AUTOMATION

JUNE 1961

Tricks in Handling Paper Products

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Steppingstones to Numerical Control
- Handling Air Horns for Machining
- Basic Sequencing Circuits
- Fixturing for Riveting

CONTENTS—PAGE 3

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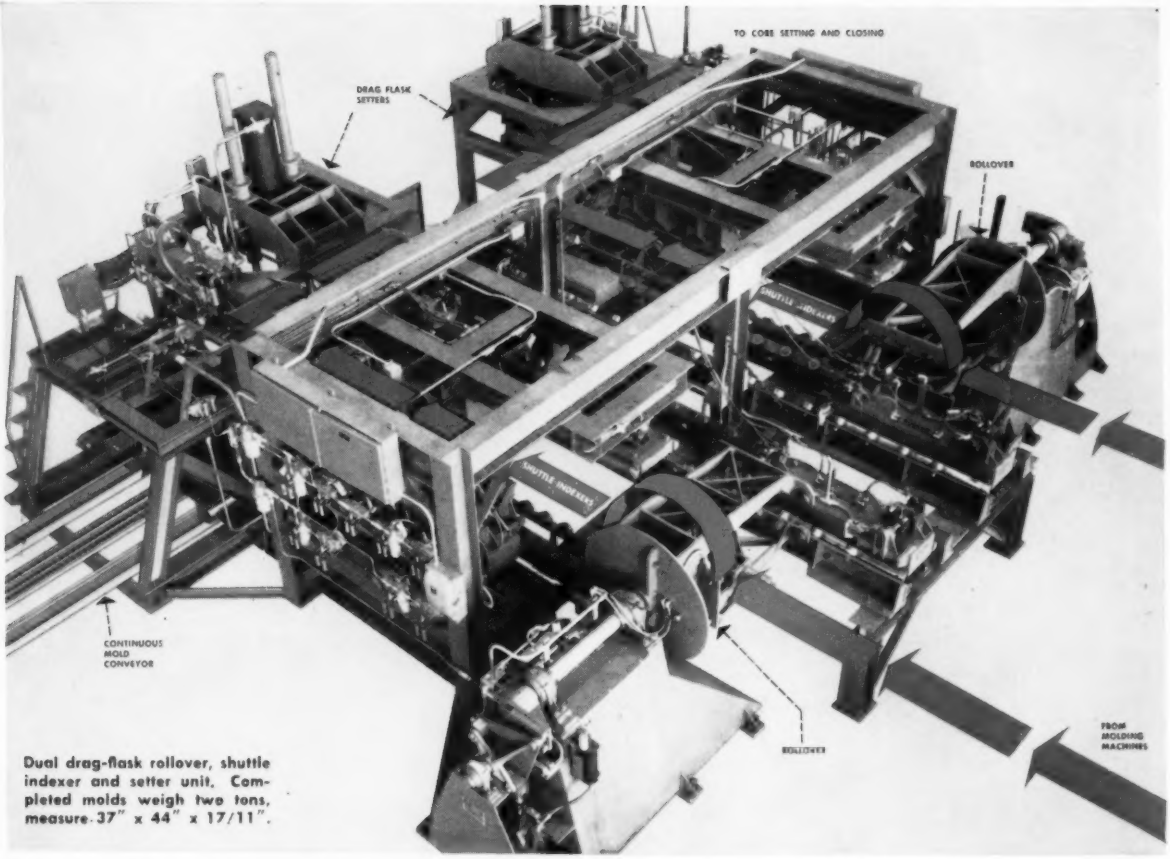

Dual drag-flask rollover, shuttle indexer and setter unit. Completed molds weigh two tons, measure 37" x 44" x 17/11".

Planet system automatically removes and positions 250 one-ton flasks an hour on moving conveyor

To design a system that will strip and close flasks automatically on a continuously moving conveyor has always been a perplexing problem. But Planet Corporation solved this problem for one of the automotive industry's largest foundries . . . and at the same time provided the key to increase productivity approximately 400%. In addition, this unusual system provides maximum casting flexibility and operational reliability.

Flask Handling System Operation . . .

Following molding, the drag flasks are fed into the dual drag-flask rollover, shuttle indexer and setter unit (see diagram). The flasks are rolled over 180°, then indexed to the unique in-flight setters which accurately positions them on the continuously moving car-top mold conveyor. From this point, they are moved through core setting to the dual cope-flask-closing unit. The cope-flask subsystem, from molding to closing, is similar to the drag-flask unit except rollovers are not required.

After pouring and cooling, the cope-flask-stripper unit lifts the cope flask off the drag. The drag flask continues on the mold conveyor to the drag "pick-off", or lifting, device. On their removal from the conveyor, the flasks are recirculated through the system. Both removal operations are performed while the mold conveyor moves as a constant speed.

This integrated materials handling system *increased productivity approximately 400% and resulted in substantial cost savings.*

Production Flexibility . . .

With this flask handling system, it is possible to produce either six-or four-cylinder blocks or both simultaneously. This feature provides this large automotive foundry with maximum casting flexibility . . . a maximum capacity of 500 blocks an hour.

Built-in Reliability . . .

Flasks handled by this system are controlled electrically and are locked at each position. They are parted or joined by lifting or lowering movements to eliminate damage to parting surfaces. The control system, which required more than 10 miles of wire and 600 relays, includes a feedback feature which allows pinpoint maintenance.

For additional operational reliability, this system was shop wired and piped, and shop tested.

An Example of Planet Versatility . . .

This is one example of Planet Versatility . . . Planet Corporation's ability to engineer, fabricate and install custom equipment that solve materials handling problems. Planet Versatility means you'll benefit from our diversified experience gained through service to leading corporations. It has paid them to plan with Planet . . . it will pay you, too! Write or call for complete information.

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- Engineered Handling Equipment
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Circle 651 on Page 35

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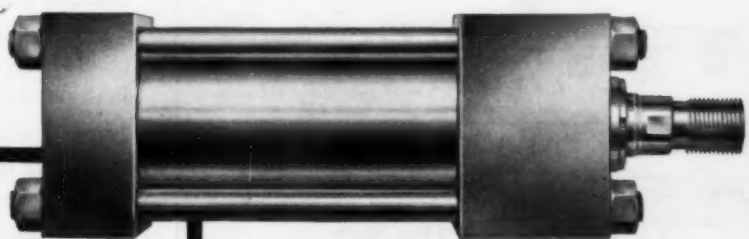
Be sure you specify *Hanna* for all your air and hydraulic Cylinders and Valves.



HANNA POWRDRAULIC HYDRAULIC CYLINDERS

2000 and 3000 psi non shock. 1½" through 8" bores.
FEATURING—Pressure Tightening Tube Seals • One Piece Steel Heads with Welded Mountings • Dual Seal Piston Rings • Fast Change Cartridge Gland • Lubricated Bearing
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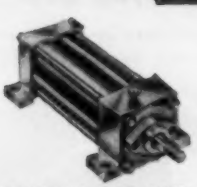

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HYDRAULIC AND PNEUMATIC CYLINDERS...VALVES...POSITIONERS

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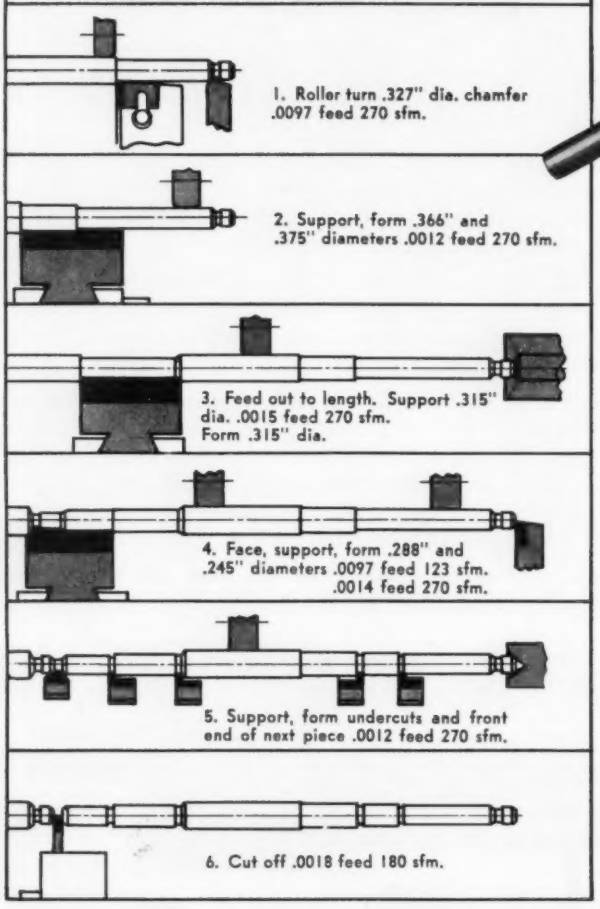
Circle 654 on Page 35

GREENLEE AIR-FEED AUTOMATICS BENEFIT "ELECTROLUX" FOUR WAYS . . .

MACHINE . . . 1"-6 Automatic Bar Machine Air-Feed — Feedout on index and in 3rd position during machine cycle.
TOOLING . . . Carbide Tipped
MATERIAL . . . 1137
STOCK SIZE . . . 13/32" rd.

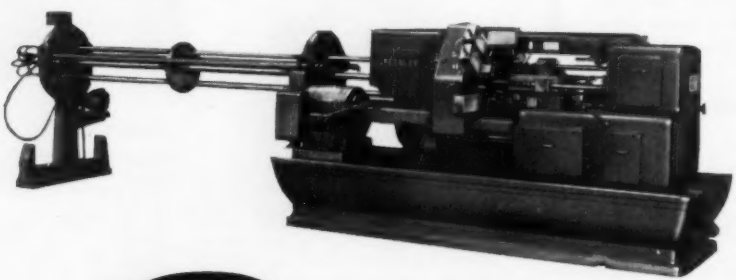
TOOL SLIDE STROKE . . 1-9/16" at .0097" feed.
SPINDLE SPEED . . . 2540 rpm 270 sfm.
MACHINE TIME . . . 5.8 seconds.
ESTIMATED GROSS PRODUCTION . . . 620 per hour


1. Roller turn .327" dia. chamfer .0097 feed 270 sfm.
2. Support, form .366" and .375" diameters .0012 feed 270 sfm.
3. Feed out to length. Support .315" dia. .0015 feed 270 sfm. Form .315" dia.
4. Face, support, form .288" and .245" diameters .0097 feed 123 sfm. .0014 feed 270 sfm.
5. Support, form undercuts and front end of next piece .0012 feed 270 sfm.
6. Cut off .0018 feed 180 sfm.

1. Eliminate stock pushers . . .
2. Eliminate scoring of stock . . .
3. Reduce downtime during set-up . . .
4. Provide extra length feed-out . . .

The part is a 6-7/8" long armature shaft used in the "Electrolux" vacuum cleaner. It demonstrates how effectively Greenlee Air-Feed Automatics and carbide tooling can team-up to increase production and reduce costs. The shaft is machined from 13/32" S.A.E. 1137 steel at a gross production rate of 620 pieces per hour. Recommended cutting speed for high speed tooling is 120 sfm. The rate was boosted to 270 sfm with carbide-tipped tooling. Sequence of operations is shown at the left.

Note how the stock is partially fed out on the index and to its full length in the third position. This provides for the most effective tooling arrangement. Greenlee Air-Feed Automatics permit greater job versatility and assure added profits. See your Greenlee representative or send us a print of your high-cost problem-part.



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Circle 655 on Page 35

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AUTOMATION

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REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Meetings and Events, 26
Around the Triangle, 33
Equipment Index, 34
Readers' Reply Card, 35
International Scene, 41
New Equipment, 101
New Components, 115
New Literature, 141
Abstracts, 155
Books, 164
Confidential File, 166
Editorial Index, 168
Advertising Index, 170

EDITORIAL OFFICES

Penton Building, Cleveland 13, Ohio

Justifiable Research, 59

EDITORIAL—job-lot manufacturers should budget funds for manufacturing research on production techniques to broaden corporate know-how.

Steppingstones to Numerical Control, 60

N. O. OLESTEN—considerations in continuous path control of machine tools are reported from experience of large aircraft subcontractor.

Handling Air Horns for Machining, 67

AUTOMATION TODAY—parts are automatically moved from a press, through four transfer machines, and loaded on conveyor hooks.

Basic Sequencing Circuits, 71

J. CARPENTER—part one of a series on industrial hydraulic circuits covers arrangements for cycling a single actuator.

Checking Temperature Gradients in Kilns, 77

MECHANIZED TESTING—thermocouple-equipped test car and recorder check temperature conditions in multizone kilns.

Tricks in Handling Paper Products, 78

J. R. HUMPHREY—features of machines and mechanisms for handling paper products at high speeds may prove useful in other fields.

Semipermanent Mold Process, 86

PRODUCTION CASTING—aluminum engine parts are cast in special equipment, machined, and inspected prior to shipment to motor plant.

Maintenance of Computer Systems, 88

T. R. DARMODY—maintaining complex electronic systems requires procedures, personnel, tools, supplies, and checking routines.

Fixturing for Riveting, 90

T. C. BUCHANAN—fundamental fixturing techniques for rivet-setting machines are discussed by referring to actual job applications.

automation outlook

MOONLIGHT

ANALYSIS of the unemployment picture in the May issue of *Nation's Business* concluded with the thought that the general outlook was "temporary unemployment for some, retraining for many, and job adjustments for all." With this sound rational statement of fact, the reader can only completely agree and ask, "was it ever any different?"

Sad but true, it appears we have created the illusion that employment has always had a stable, unchanging pattern. Except for some professions, employment in modern times has had but one constant—change—change due to a myriad of technical, business, and human factors too numerous to list.

Can automation actually be claimed as a prime cause of long-term unemployment? Many economists such as Presidential Advisor, Paul Samuelson, say no. A look at the statistics indicates this is true. If all new equipment spending of 1960 were used for automating, the average investment needed per worker would indicate that roughly half a million jobs could be displaced. At a maximum, however, actual displacement is estimated at perhaps 200,000.

What does a close look at present data reveal? It is certainly a much different picture than a look at any special segment reveals. With the April employment the highest on record for that month, the official "unemployed" figure by the Labor Dept. was 4.96 million. By allowing an average of 2.5 per cent of the total workforce for voluntary changes of short duration that are always present, the resulting 1.77 millions drops the significant total figure to 3.19 millions. Overlaps, duplications, and plain distaste for work has an unfortunate tendency to overstate actual unemployment in the total that is left.

But what of the sequel to the story—the fact that many jobs are going begging? An interesting facet that emphasizes the growing demand for special skills is moonlighting. It is estimated that perhaps as many as 4 million persons hold two or more jobs in special fields, almost double that of a decade ago. This, along with unfilled jobs available creates a total that far overshadows the unemployed total. But the vast majority of this work falls into the highly skilled category.

The conclusion? It appears that our concern and study must effectively concentrate on developing new skills and extended education among the unemployed. How can such development be stimulated? One solution would be to tie unemployment benefits to study programs, retraining, and crafts. Retired vice president of the United Steelworkers of America, Harvard lecturer and board member of the Ford Foundation's Fund for Adult Education, Clinton S. Golden puts it this way, "It's going to take a lot of education and a lot of planning but if we don't do it, we're in trouble, serious trouble."

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BPA NBP

...Fluid Power news

OILGEAR 40 Years of Fluid Power

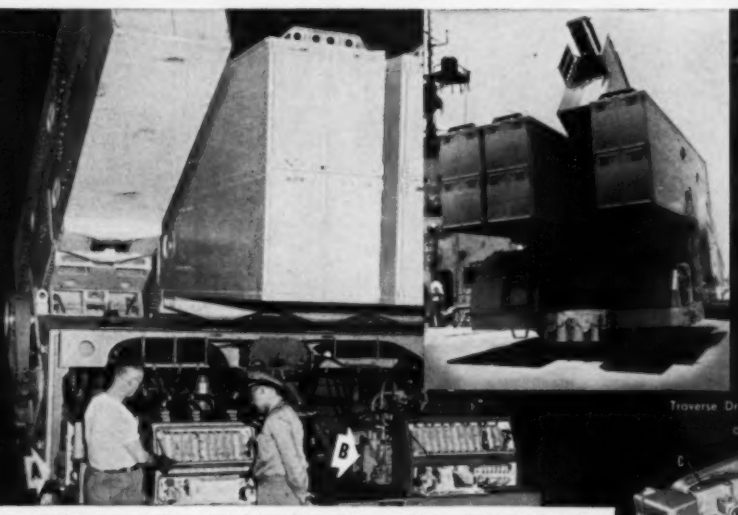
Report No. 11,400 From Oilgear *Application-Engineering* Files

HOW OILGEAR ELECTROHYDRAULIC SERVO-VALVE-CONTROLLED DRIVES AIM *ASROC** MISSILE LAUNCHERS IN RESPONSE TO LOW-POWER SIGNALS FROM SHIPBOARD DIGITAL COMPUTERS.

**ASROC (Anti-Submarine ROCket) — the Navy's deadliest, integrated, anti-submarine weapons system — consists of 4 major parts: an underwater sonar detection device; an electronic, digital, firecontrol (aiming) computer; a "pepper-box" type, 8-missile launcher; and ASROC missiles. Within seconds after sonar detection of a hostile submarine, the computer charts its course, speed, and range — correlated with the ASROC-equipped ship's course, speed, and roll. The resultant computer signals command the launcher to traverse and elevate instantly to accurate "aim" position, and continue to "track" from subsequent computer command signals. The ship commander merely pushes a button to fire either rocket-propelled, homing torpedos or depth charges.*

PROBLEM: Power and control for both the traverse and elevation drive systems to "aim" ASROC missile launchers in response to direct, low-power, electrical command signals from a digital firecontrol computer.

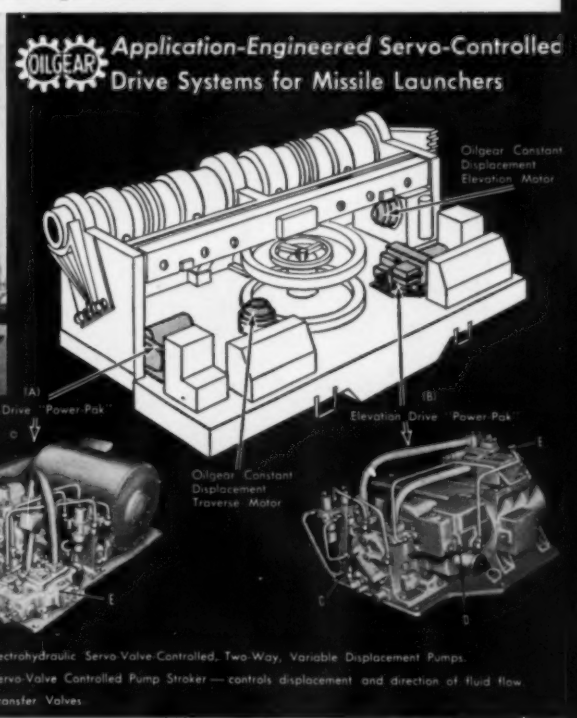
REQUIREMENTS: 1. High traverse and elevation speeds in either direction, with shockless reversal, to bring launcher "on target" — rapidly. 2. Fast, accurate control response for high-speed "homing." 3. Precisely controlled, low variable speeds for "tracking." 4. Entire drive and control systems to occupy a minimum of space within the launcher base. 5. Dependability — "no time-out permitted" — a rigid requirement for fleet use. 6. Unitized assemblies preferred, to facilitate installation and replacement.



Official Photos — U.S. Navy. Actual launcher performance data is classified information.

ABOVE: ASROC missile launcher being checked at U.S. Naval Ordnance Plant, York, Pennsylvania. Arrows indicate traverse (A) and elevation (B) Power-Paks. **INSET:** ASROC launcher ready to fire aboard U.S.S. Norfolk. Each of the 8 cells serve as missile stowage magazines and launchers — all traverse as a unit . . . each over/under pair of cells elevate individually. 360° launcher traverse is possible, but a quadrant is blocked to protect ship's superstructure. Missiles weigh about 1,000 lbs., are about 15 ft long. Launcher base sketch, right, approximates position of Oilgear Drives.

SOLUTION: With Oilgear's experience in meeting the speed, control, and precise turret and gun performance requirements for U.S. Army tanks, howitzers, and anti-aircraft guns — this missile launcher application was a "natural" for Oilgear *ANY-SPEED* Drives — and the alert, accurate response of Oilgear's Electrohydraulic Servo-Valve-Controlled, Two-Way, Variable Displacement Pumps. Amplified signals up to 5-watts actuate drive controls. Cushioned, full-speed drive reversal. These small, rugged, Oilgear *ANY-SPEED* Pump and Motor Drives easily convert output from constant speed electric motors into the exact, required traverse and elevation speeds, direction, and torque . . . even under high overload conditions. An automatic feedback control compensates for load, voltage, or viscosity changes to accurately maintain computer-selected speeds. Torque transmitted automatically increases or decreases to a point just sufficient to overcome resistance. There's no "wire-drawing," or bypassing of fluid to generate heat or waste power. Both systems are totally enclosed, automatically protected against overload, pressure and flood lubricated to assure long, dependable, maintenance-free, service life.


OILGEAR Application-Engineered Servo-Controlled Drive Systems for Missile Launchers
Oilgear Constant Displacement Elevation Motor
(A) Traverse Drive Power Pak
(B) Elevation Drive Power Pak
Oilgear Constant Displacement Traverse Motor
(C) Oilgear Electrohydraulic Servo-Valve-Controlled, Two-Way, Variable Displacement Pumps.
(D) Oilgear Servo-Valve Controlled Pump Stroker — controls displacement and direction of fluid flow.
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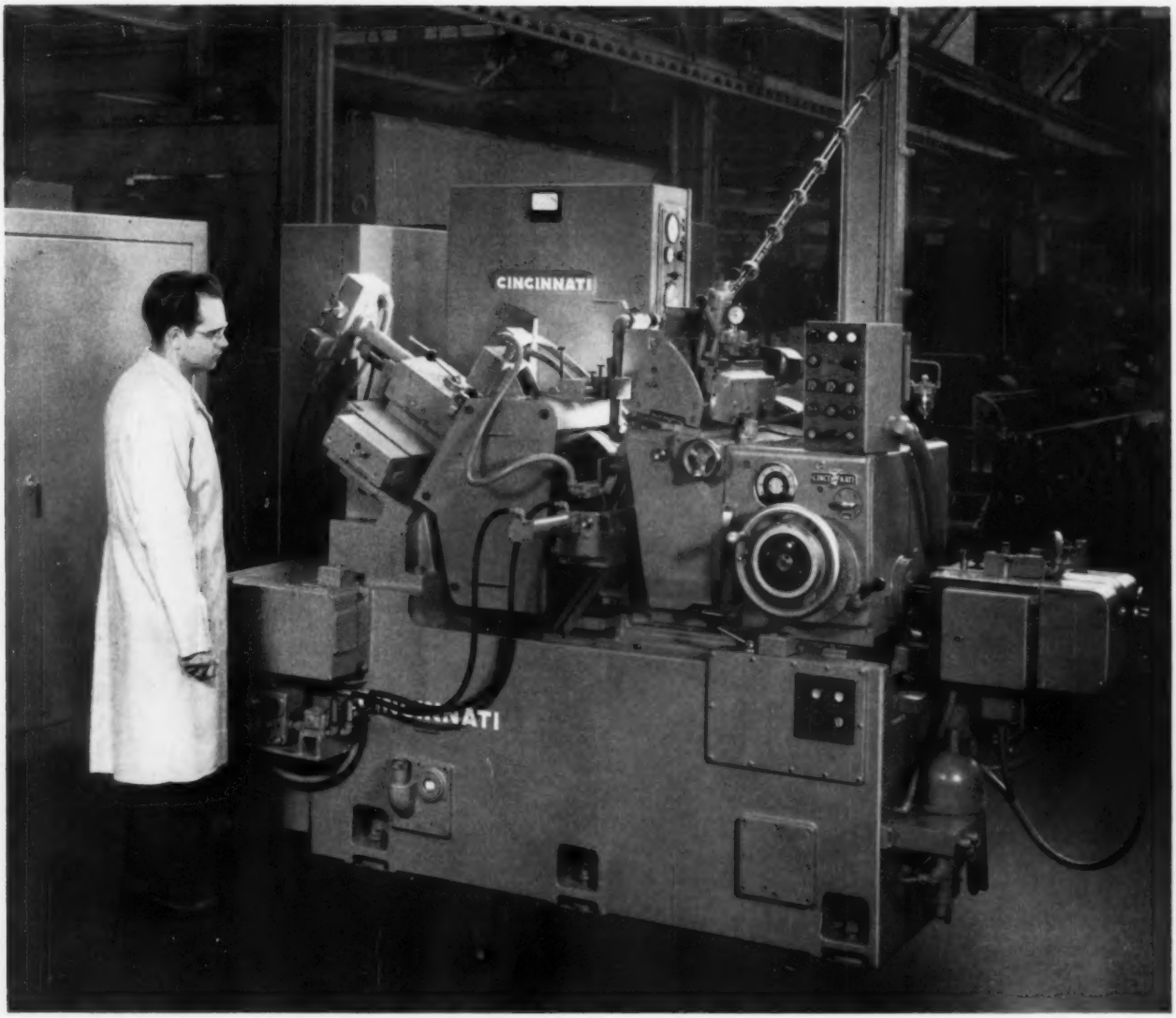
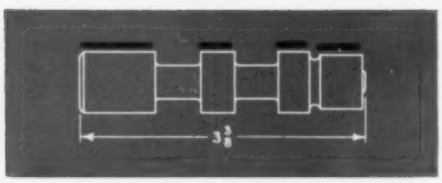


Precise cost control is attained in precision grinding transmission valves on this CINCINNATI FILMATIC Centerless Grinding Machine equipped for completely automatic operation.

CINCINNATI

FILMATIC



Part drawing. Heavy lines indicate ground diameters.

Part name	transmission valve
Material	hardened steel
Operation	grind two diameters
Production	250 per hour (80% efficiency)

BUILDERS OF PRECISION GRINDING MACHINES: CENTERTYPE • CENTERLESS • MICRO-CENTRIC

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

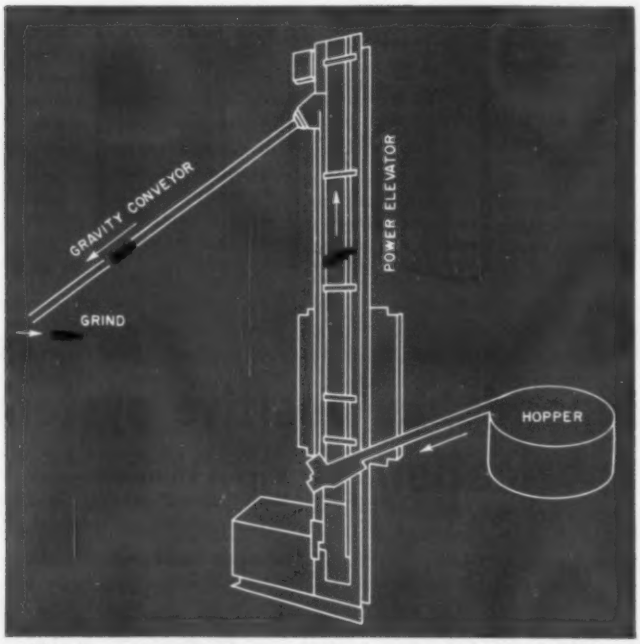
COST CONTROL...

CINCINNATI CENTERLESS is equipped to Grind, Handle and Gage the Work... AUTOMATICALLY

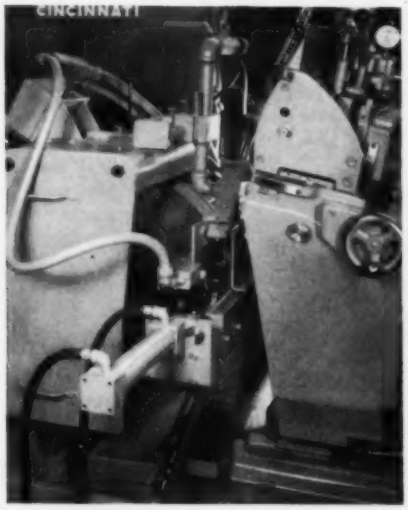
Better cost control at the machine level is the modern approach to efficient volume production. Cincinnati Engineering Service Specialists are well acquainted with this approach, and employed it in equipping a CINCINNATI FILMATIC Centerless Grinding Machine to grind two diameters on transmission valves.

Cost control equipment includes: automatic grinding wheel balancing . . . push-button automatic grinding wheel truing with cycle counter . . . electro-hydraulic automatic infeed attachment arranged with automatic compensation for wheel wear and truing . . . hopper feed and elevator . . . automatic loading, locating and ejecting fixture . . . air-electric in-process gaging . . . and, of course, FILMATIC grinding wheel spindle bearings.

This production package performs an excellent job of grinding the parts at a dependably low cost and at a production rate of 250 per hour (80% efficiency). It is typical of the work of Cincinnati Grinding Specialists, and the way in which Cincinnati can help you reduce costs by replacing productively obsolete machine tools with new machines and methods. May we hear from you? Our Grinding Specialists will gladly study your production problems and cost structure, and make recommendations.



Work flow diagram. Parts are automatically ejected at front of machine.



The forward end of the fixture automatically takes the part from the conveyor and locates it between the wheels.

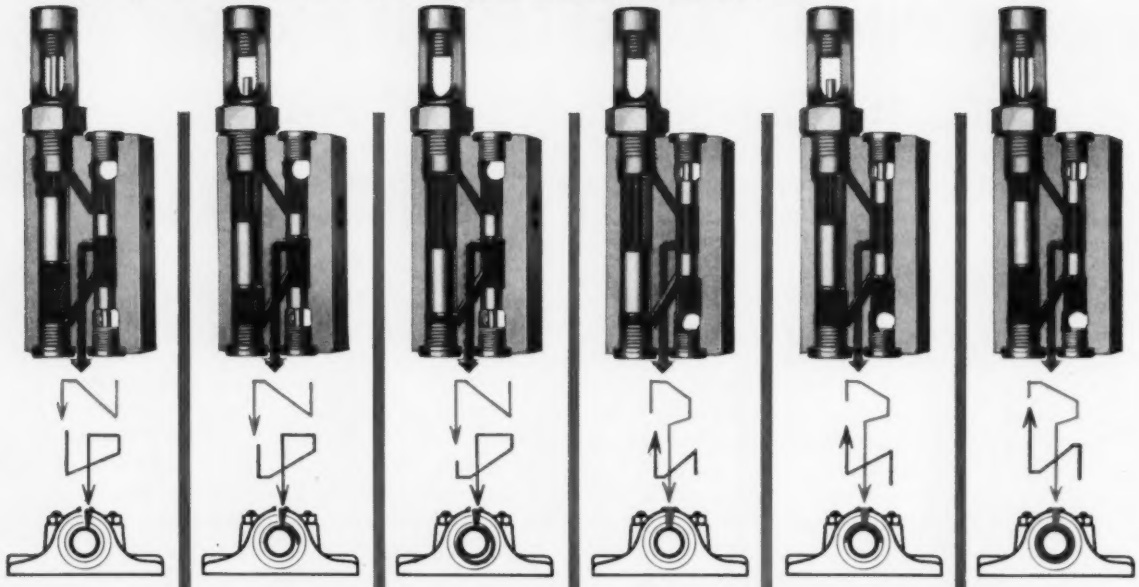
• ROLL • CHUCKING • CENTERLESS LAPPING

CINCINNATI®
GRINDING MACHINE DIVISION

Circle 656 on Page 35

Here's design simplicity

Farval's Time-Tested Dualine Valve



1

(In red) Lubricant under hydraulic pressure enters inlet at top right — pushing slide valve down and filling upper diagonal passage and chamber above main piston.

(In blue) By this movement, lower head of piston slide valve uncovers lower diagonal passage leading from the main piston chamber. This chamber is full of lubricant from the previous operation.

2

(In red) Lubricant under pressure entering through upper inlet port and into main chamber continues to force main piston downward —

(In blue) discharging lubricant through lower diagonal passage to vertical passage and to outlet port leading to bearing.

3

(In red) Lubricant entering from upper port has now forced the main piston to end of its stroke, and thus the full measured charge below piston has been delivered to the bearing.

Note that indicator stem has also moved down, indicating main piston has reached end of its stroke, and that no more lubricant will be delivered from this operation.

4

(In blue) Lubricant under hydraulic pressure enters inlet at bottom right — pushing slide valve up and filling lower diagonal passage and chamber below main piston.

(In red) By this movement, upper head of piston slide valve uncovers upper diagonal passage leading from the main piston chamber. This chamber is full of lubricant from the previous operation.

5

(In blue) Lubricant under pressure entering through lower inlet port and into main chamber continues to force main piston upward —

(In red) discharging lubricant through upper diagonal passage to vertical passage and to outlet port leading to the bearing.

6

(In blue) Lubricant continuing to enter under pressure from the lower port has now forced main piston to the end of its stroke, and thus the full measured charge above piston has been delivered to the bearing.

Indicator has reached its top limit, showing the job is done.

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Farval Studies in Centralized Lubrication No. 255

Only Farval has all these vital features

No Springs
No Check Valves
No Small Ports
Measures By Piston Displacement
Has But Two Moving Parts
Is Individually Adjustable
Will Distribute Either Oil Or Grease
A Positive Indicator At Every Bearing

Circle 657 on Page 35

AUTOMATION news

Today's events and developments in the field of automation

Welding with Mechanical Energy

FRICTION between two objects is used to weld them together on equipment shown recently at the American Welding Society Exposition by American Machine & Foundry Co. The idea is not new —some patents go back to the 1800's—but increased attention has been given this subject in Europe and particularly the U.S.S.R. in recent years.

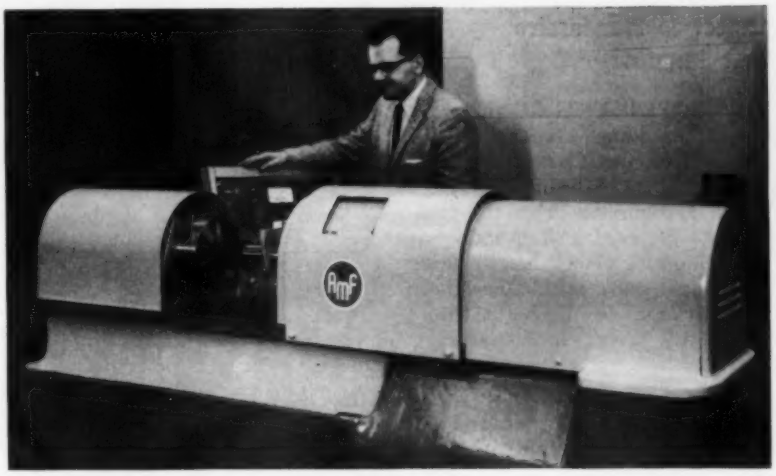
In friction welding, heat is generated by mechanically revolving one object while it is pressed against a stationary object. After a controlled period of time the rotation is stopped, and the pressure is increased and held for another specified period.

Heat necessary for the formation of a weld can be generated either by applying high pressure and slower rotational speed or by applying high speed and comparatively light pressure. Russian scientists chose the high pressure method, AMF scientists chose the high speed method.

To illustrate the two approaches, consider the welding of two chrome alloy steel bars. The Russian method might involve a speed of 1200 rpm at a pressure of 14,000 psi. The AMF method would use a speed of 12,000 rpm and a pressure of 2000 psi.

By either method the process is highly adaptable to automated operations. Also it is adaptable to the welding of a wide range of different materials—copper to brass, brass to aluminum, aluminum to steel, high alloy to low carbon steel, ceramics, plastics, and others. In many instances this welding process eliminates the need for fluxes and special atmospheres.

For a given size of weld, the friction process is actually more efficient than conventional methods and has a lower requirement. About 6 hp is required per square-inch of cross section to friction weld low carbon steel. Since the main power needed for friction welding is that to provide rotation, the power source need not be electric—it could be a gasoline or diesel engine.



FRICTION welding unit is demonstrated by Frank Camps-Campins, research engineer who worked on it at Research & Development Div., American Machine & Foundry Co., where the unit was developed. One of the parts to be welded is held stationary while the other is rotated and pressed against the first. The technique welds a wide range of materials including copper, brass, aluminum, steel, ceramics, and plastics.

Almost any bar or tube can be friction welded to another bar, tube, or flat plate. Practical range of diameters is basically from ¼ to 12 inches. The process is best suited to the butt joining of bar stock or tubes between ½ and 8 inches in diameter. There is no particular restriction on the length of bar or tube to be welded.

The friction welding process usually takes between 3 and 60 seconds to complete a weld. Time of welding is not as dependent on diameter as it is on material. For example, 10 seconds is required to weld two aluminum bars whether they are one or four inches in diameter. Welding two high carbon steel bars that are four inches in diameter takes about 40 seconds.

Several advantages are claimed for the AMF high speed method as compared to the Russian high pressure method. First, that weldments are sounder and results can be controlled better. Furthermore, that use of lighter pressures makes possible the use of lighter, high speed, less expensive machinery. Also because lower pressures are involved, there is less deformation or damage to the unwelded sections; less chance for cracks, premature seizing, overstressing, or distortion of the work. The high rotational speeds also assure better cleansing of the abutting surfaces.

A typical AMF cycle for welding high alloy to low carbon steel might spin the rotating part at 12,000 rpm. As the rotating part contacts the stationary part over a 20-second period pressure gradually is built up to 2000 psi and held for about

30 seconds. Temperature rises to about 2700 F and metal at the point of contact melts. The rotation is then stopped as rapidly as possible, usually in about half a second. Pressure is increased to 8000 psi and held about 60 seconds or until the temperature drops to approximately 600F.

Expect to Standardize Belt Lengths

STANDARDIZATION of the lengths of coated abrasive belts is an aim of the Coated Abrasives Manufacturers Institute. After a study, a committee from the institute has proposed a sharp reduction in the number of belt lengths to be made, and has asked machinery manufacturers to design machines which will accept the standardized lengths.

Under existing specifications, no fewer than 104 different belt lengths are being manufactured in lengths from 12 through 168 inches; some are being made to sixteenths of an inch. The committee has proposed the manufacture of coated abrasive belts in 31 lengths; in 3-inch increments from 12 through 36 inches, and in 6-inch increments from 42 through 168 inches.

Its analysis of machine specifications identified 278 belt-using machines now in production; of that number, 154 already used one of the 31 proposed lengths. This left 124 machines which required belts not covered by the proposed standards. The committee then asked manufacturers of these 124 machines to consider revising or adjusting them to accept the nearest proposed belt length, and to follow the new standards when designing a new machine. It was pointed out that existing designs could be changed at slight cost by altering their tensioning devices or by changing pulley diameters. Virtually all of the manufacturers polled agreed to co-operate in any future designs.

Attendees Beat the Weather to Reach Fifth Conference on Manufacturing Automation

MANY attendees and speakers were delayed and some snowbound as they journeyed to Purdue University at Lafayette, Ind., for the Fifth Conference on Manufacturing Automation, April 17-19. Four of the representatives from AUTOMATION spent some 21 hours as temporary guests in the Apostolic Christian Church in Francesville, Ind. Kindly families of the church supplied food and bedding to go with the hardwood pews that served as beds.

Other reports were given by storm-buffeted travelers of welcome lodgings in jail, automobile dealership, school, and farm buildings. Some even spent Sunday night, April 16, in stalled automobiles. In the age of space exploration it was indeed ironical that snowflakes could interfere with a conference on manufacturing automation.

With adjustments in scheduling of early sessions, the conference was carried through to a successful conclusion with every presentation being made. Despite the adverse weather, some 170 participants were on hand representing organizations from coast to coast.

As the conference schedule was smoothed out, special discussion groups were a valuable part of the conference proceedings as they have been in preceding years.

UNIVERSAL checkout equipment checks electrical and hydraulic missile guidance systems. Building block design permits off-the-shelf assembly of a test installation of almost any complexity. A combination unit both programs the tests to be performed and converts the results into digital information for readout on typewriter or printer. Equipment includes other building block modules such as power supplies, signal generators, comparators, and data storage units. Each element is capable of handling up to 400 test points and scanning them at a rate of up to four points a second. The readout can be in numerical order from 1 to 400, or in any other sequence selected by the program tape. The tape can also be used to decide whether the circuit under test meets specifications. The correct value for each test is included in the taped instruction, and this is compared to the actual reading. Engineers at Convair (Pomona) Div. of General Dynamics Corp. developed the flexible checkout equipment. Part under test in installation shown is a gas pressure system on console shelf at right.

In-the-Field Application of Rubber Lining Material

INDUSTRIAL RUBBER lining material that cold-bonds to metal and other surfaces with field-applied cement has been developed by Goodyear Tire & Rubber Co. The covering is designed to protect interior surfaces of chutes, mills, and cyclone collectors against impinging

THREE BILLION DOLLAR VOTE OF CONFIDENCE

in the future of OHIO

To keep pace with Ohio's dynamic growth, the state's eight investor-owned electric power companies will spend three billion dollars in the coming decade to double capacity. As much new generating capacity will be provided in the next ten years as was built in the past seventy-five.

If you are seeking a plant site, these facts are important for two reasons. First, this is solid indication of the confidence electric utilities have in Ohio's future growth. Second, you can be sure there will be plentiful, dependable electric power for your industry. Today, Ohio's generating capacity is 10.6 million kilowatts, and this state is the number one user of electric power in the nation.

Additional information detailing vital plant site factors is yours for the asking. Send the coupon below on your letterhead for two new booklets of solid facts: Statistical Abstract of Ohio: 1960 and Ohio, The Growth State.

Koder M. Collison, Director
State of Ohio, Department of Industrial and Economic Development
700 Bryden Road Columbus 15, Ohio

Please Send:
☐ Statistical Abstract of Ohio: 1960
☐ Ohio, The Growth State brochure

NAME _____ TITLE _____

BUSINESS ADDRESS _____

CITY _____ ZONE _____ STATE _____

Circle 658 on Page 35

abrasion and chemical action of inorganic salts, alkalis, and acids. The material, with its tie-gum backing, is also suitable for recapping conveyor belts.

MEC Elects National Officers

AT the Annual Meeting of the Manufacturing Engineering Council held in conjunction with the Fifth Conference on Manufacturing Automation, a new slate of officers was elected for the coming year. **Harry C. Hibler** of Designers for Industry, was elected president. Other electees include: Vice President **Walter A. Stadtler,** of IBM Corp.; Treasurer **Fredrick I. Ellin,** of Ohmite Mfg. Co.; Membership Chairman **Roger W. Bolz,** of AUTOMATION. These officers also serve as directors of the council. This professional society for engineers and management dedicated to the advancement of scientific knowledge for the improvement of manufacturing techniques in all industries also announced the following as directors of the organization: **Murray D. Braid** of Thompson-Ramo-Wooldridge Valve Div., **Joseph E. DuQuette** of Magnavox Co., **William C. Leone** of Rheem Mfg. Co., **Milton R. Nielson** of Booz Allen Applied Research, and **Michael Zajac** of Buhr Machine Tool Co.

FLUIDIZED BED industrial furnace was developed for heat treating super alloys and exotic materials by Boeing Airplane Co. Basis of the furnace is tiny, air-agitated refractory particles, buoyed and kept in suspension by an air or gas stream. Heated, they maintain a uniform temperature throughout the furnace and allow rapid changes in heat. An agreement for the manufacture and sale of the furnace was made by Boeing and the Electric Furnace Co. and its subsidiaries, Turnkey Engineering Co. and Canefco Ltd.

LEASING SHOWS LOTS OF LIFE

AMERICAN industry in 1960 leased production and office equipment worth more than $530 million reports **Robert Sheridan,** president of Nationwide Leasing Co. Professional leasing companies leased $197 million of equipment and equipment manufacturers leases direct to their customers amounted to $333 million. The past year's leasing volume represents a 35 per cent gain over 1959, when leasing volume totaled $392 million. Sheridan predicted leasing volume will top $1 billion by 1962, and these figures do not include leasing of autos, trucks, railroad rolling stock, real estate, or buildings.

The ten industries which leased the most equipment in 1960 were (in alphabetical order) chemicals and drugs, department and chain stores, electrical equipment and machinery, fabricated metal products, food products, milling and feed production, paper and allied products, petroleum, shoes and leather, and the supermarket industry.

FARRINGTON LEASING CORP. and Farrington Leasing Corp. (Canada) Ltd. have been formed to handle the expanding volume of leases of equipment built by Farrington Mfg. Co. The leasing companies are taking title to all presently rented machines, with no change in the rental rights of present lessees.

NATIONAL EQUIPMENT RENTAL LTD. has announced a short term lease plan for government contractors whose contracts may be abruptly cut back or cancelled. Leases as short as six months are available to prime and sub-contractors for research and development equipment as well as production and service machinery.

DAYSTROM INC. has announced a contract with Nationwide Leasing Co. to provide a long-term lease plan covering equipment produced by Daystrom's Industrial Products Group. Leases may range from as little as $100 and up to several hundreds of thousands. Normal periods will be from 39 to 65 months but special cases may range from two to ten years.

NATIONAL ACCEPTANCE CO. has announced their entry into the equipment leasing field. They will buy from and pay the seller for equipment selected by the user. The user will then pay a monthly rental.

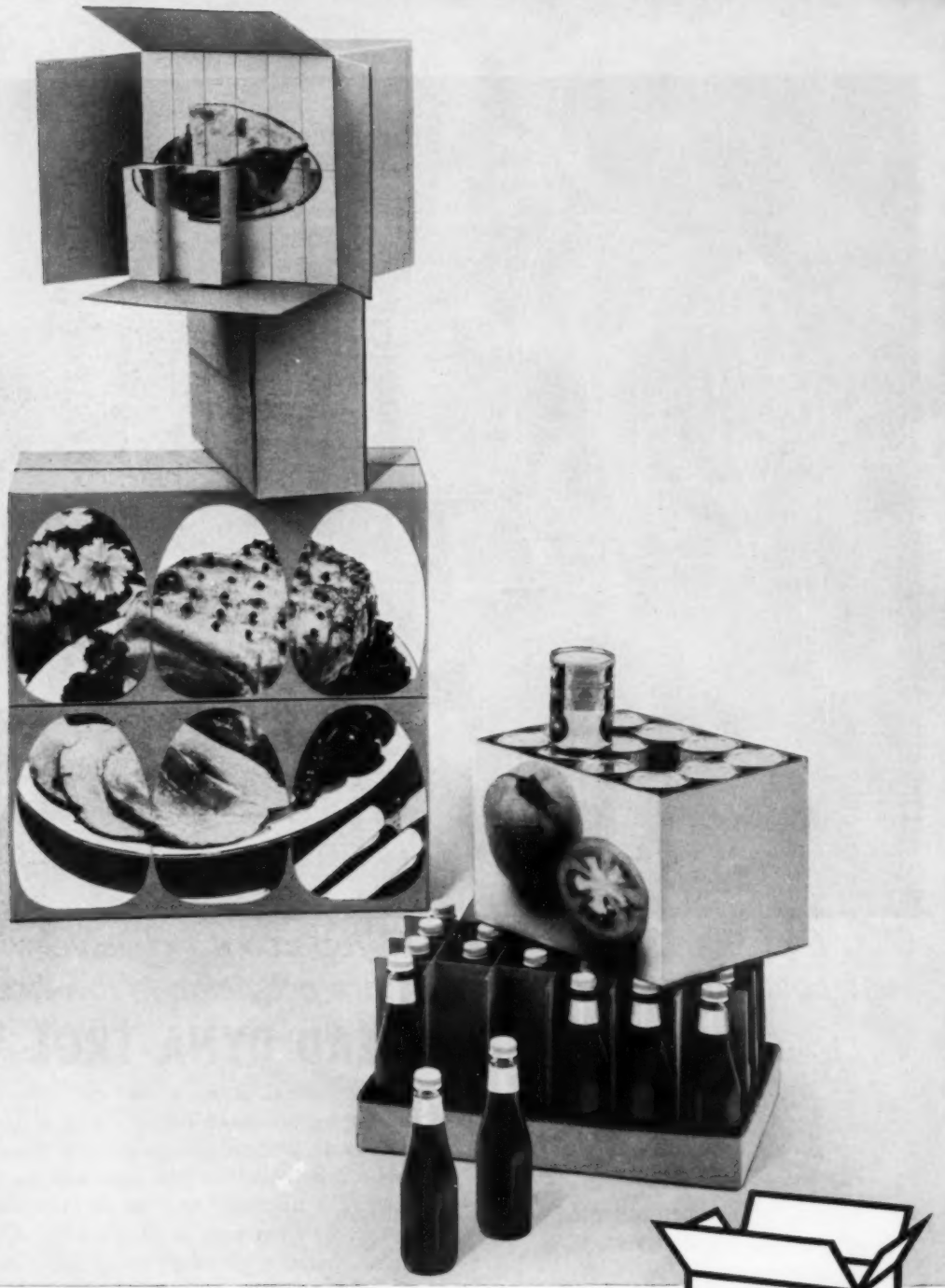
INFRARED sensitive television camera that can see temperature is being manufactured by Fairbanks, Morse & Co. The camera is able to see an object, such as a steel plate, when the object reaches 850F. The infrared tube is also sensitive to visible light.

New Machines Process Semiconductor Materials

TWO MACHINES used in the wafering and lapping of semiconductor materials will be manufactured by Machine Tool Div., Norton Co. The materials are used in solid state electronic devices such as transistors.

The machines are: A multi-blade wafering machine and a four-way lapping machine. Approximately 300 wafers 0.010-inch thick can be cut from a single ingot by the wafering machine. Blades on the machine are 0.008-inch thick, are precisely spaced and under tension, and cut the ingot with a reciprocating motion.

Table top sized lapping machine insures stress-free lapping. One model handles work as thin as



Millions of meals in corrugated

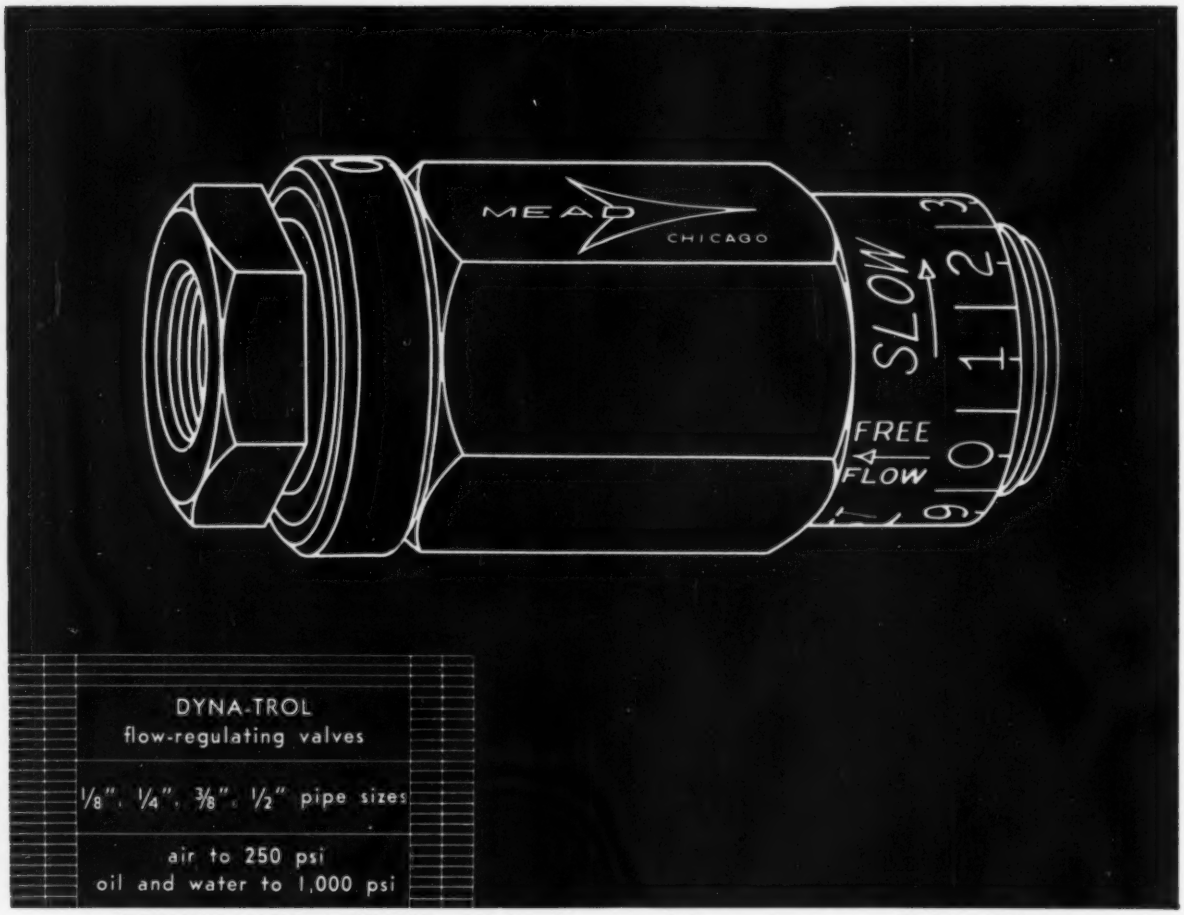
From appetizer to dessert, every course in the American menu is rich with the variety of a thousand different dishes, served by the nation's legion of food producers. Many of these leading companies use boxes by Hinde & Dauch. And for good reason: They can rely on H&D to supply money-saving *corrugated containers in volume.*

Circle 659 on Page 35

West Virginia Pulp and Paper

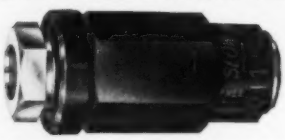
Hinde & Dauch Division

17 Plants • 42 Sales Offices • Sandusky, Ohio



PROBLEMS: how to replace a 1/4" valve with a less-costly 1/8" valve (and get extra precision in low-flow ranges)

SOLUTION: NEW MEAD DYNA-TROL VALVE



Check these design advantages of the new MEAD DYNA-TROL flow-regulating valve:

- Adjusting sleeve — easily rotated by hand — locks to any setting and cannot be accidentally removed from valve body
- Calibrated sleeve records settings for future reference
- Knife-edge variable orifice reduces flow distortion caused by viscosity changes in working medium
- No internal springs to cause malfunction
- All parts rust-proof
- Wide operating range: −40° F. to +250° F.

Small, economical MEAD DYNA-TROL flow-regulating valves can replace more costly valves of larger pipe size. Reason: Internal design permits pneumatic or hydraulic flow equal to full pipe area in both directions. The first 360° turn of the adjusting sleeve increases flow from zero to about 10% of potential — a new measure of precision in low-flow ranges. Successive turns accurately reach 100% of pipe capacity. To cut costs and give exacting control to piston speeds, specify MEAD DYNA-TROL valves to solve your flow regulating problems. For information on quick delivery, write to MEAD *today*.

PRODUCTS FOR AUTOMATION

MEAD FLUID DYNAMICS

A DIVISION OF MEAD SPECIALTIES CO.
4114 N. KNOX AVE., Dept 261, CHICAGO 41, ILL.

ASK YOUR MEAD MAN for more dollar-saving automation ideas

Circle 660 on Page 35

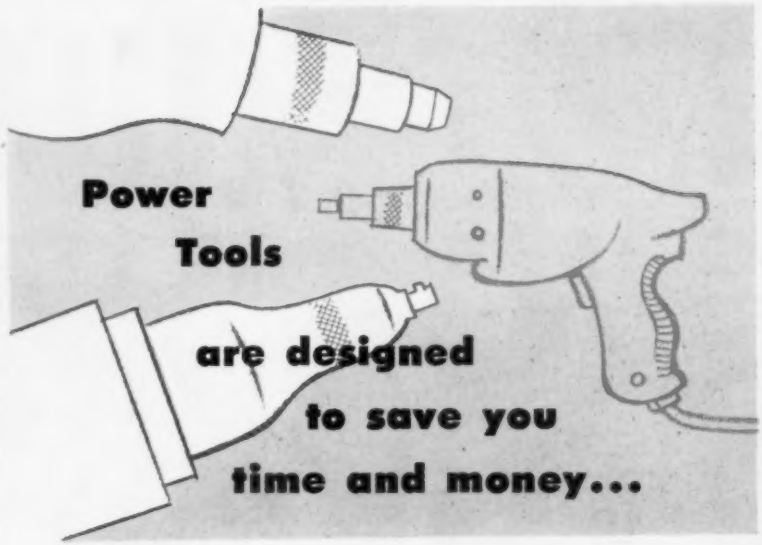
ROTARY spot printer for imprinting cut-to-length galvanized sheets has been designed by Jas. H. Matthews & Co. The electronically operated printer can control the position and number of trademarks or imprints per sheet. It is mounted over the galvanized sheet conveyor line just before the piler and after the roller leveler. Because the printer is mechanically driven, only the printing die comes in contact with the sheet surface, eliminating the danger of surface marring or distortion on even the lightest gage sheets.

0.006-inch, while another is designed for lapping to 0.003-inch. Irregular or broken wafers can be lapped in the machine without danger of their sliding under the carriers and scratching other wafers being lapped.

RCA Furnishes Gamma Ray Gaging Systems

ENTRY into the nuclear gaging field has been announced by Radio Corporation of America Industrial Controls. A complete line of gamma ray gaging systems is available to measure precisely the thickness and density of such materials as pipes, steel plates, and laminations of steel, nickel, or other metals. The systems can also be used for applications in the inspection and quality control of thickness and density in production operations, for the detection and control of voids and seams, and for liquid level control of fermentation tanks, metal smelting furnaces, and oil storage tanks.

TEFLON SEALS with built-in expansion elements overcome the tendency for Teflon seals to shrink away from sealing surfaces when temperatures are reduced. Tanner



There are over 7,000 types and sizes of Apex Nut Running and Screwdriving Tools, for use with all popular makes of air and electric power tools.

NUT RUNNING TOOLS

Catalog 30-A—¼", 5/32", 3/16", ½", 5/16" square drives, ¼", 5/16", 7/16", 5/8" hex drives.

Catalog 30-B—¾", 1", 1¼", 1½", 2½", 3½" square drives, 7/16", 5/8", ¾" hex drives.

Catalog 30-D—Specials and Spline Drive.

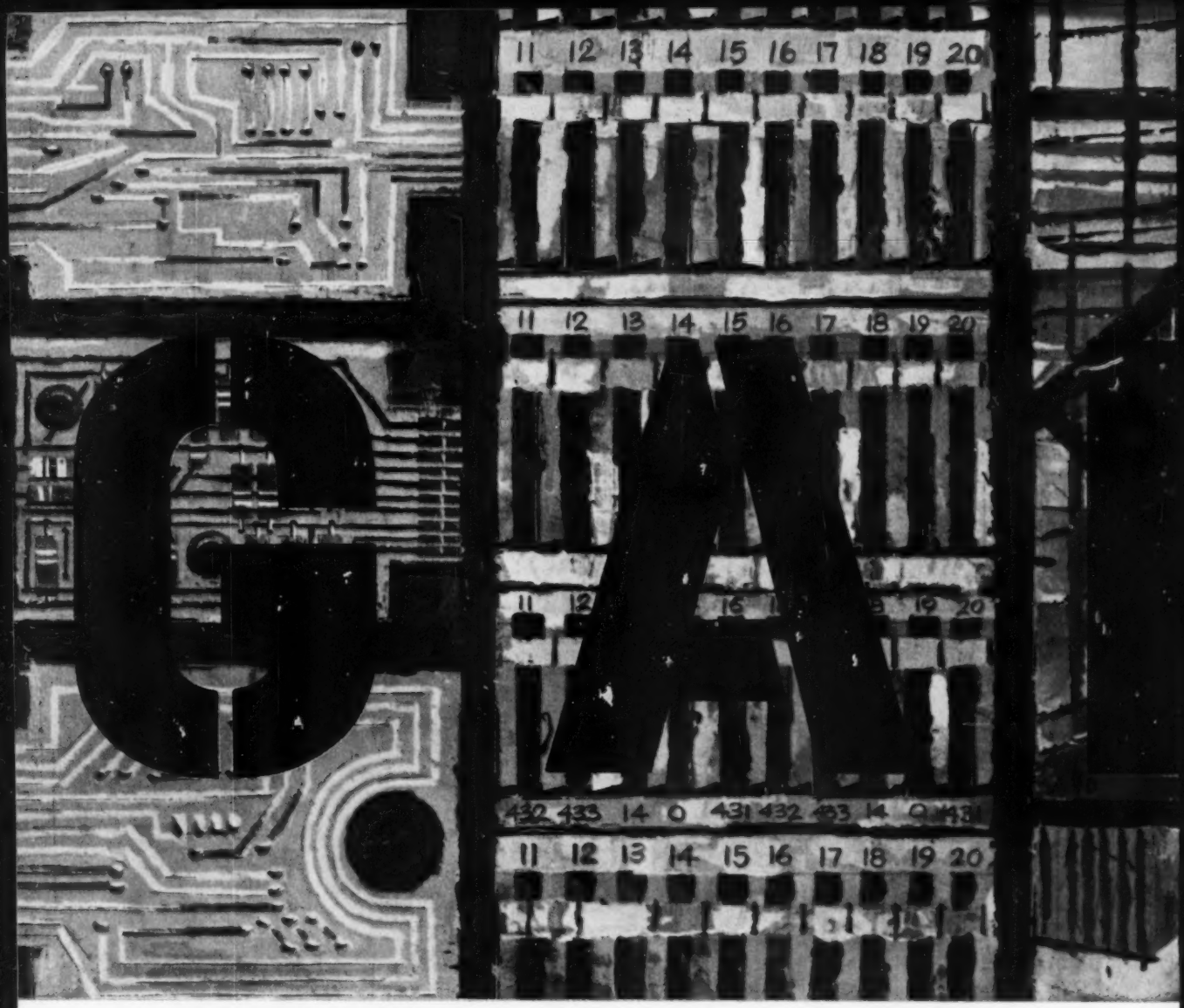
SCREWDRIVING TOOLS

Catalog 30-C—Standard and Magnetic.

SPLINE DRIVE

APEX FASTENING TOOLS
SCREWDRIVING • NUT RUNNING • SPECIAL

Circle 661 on Page 35



G Gathers automatically the information the operator needs to supervise the plant.

A Alarms off-limit quantities... automatically warns when an unsafe value occurs and logs all points exceeding pre-set limits.

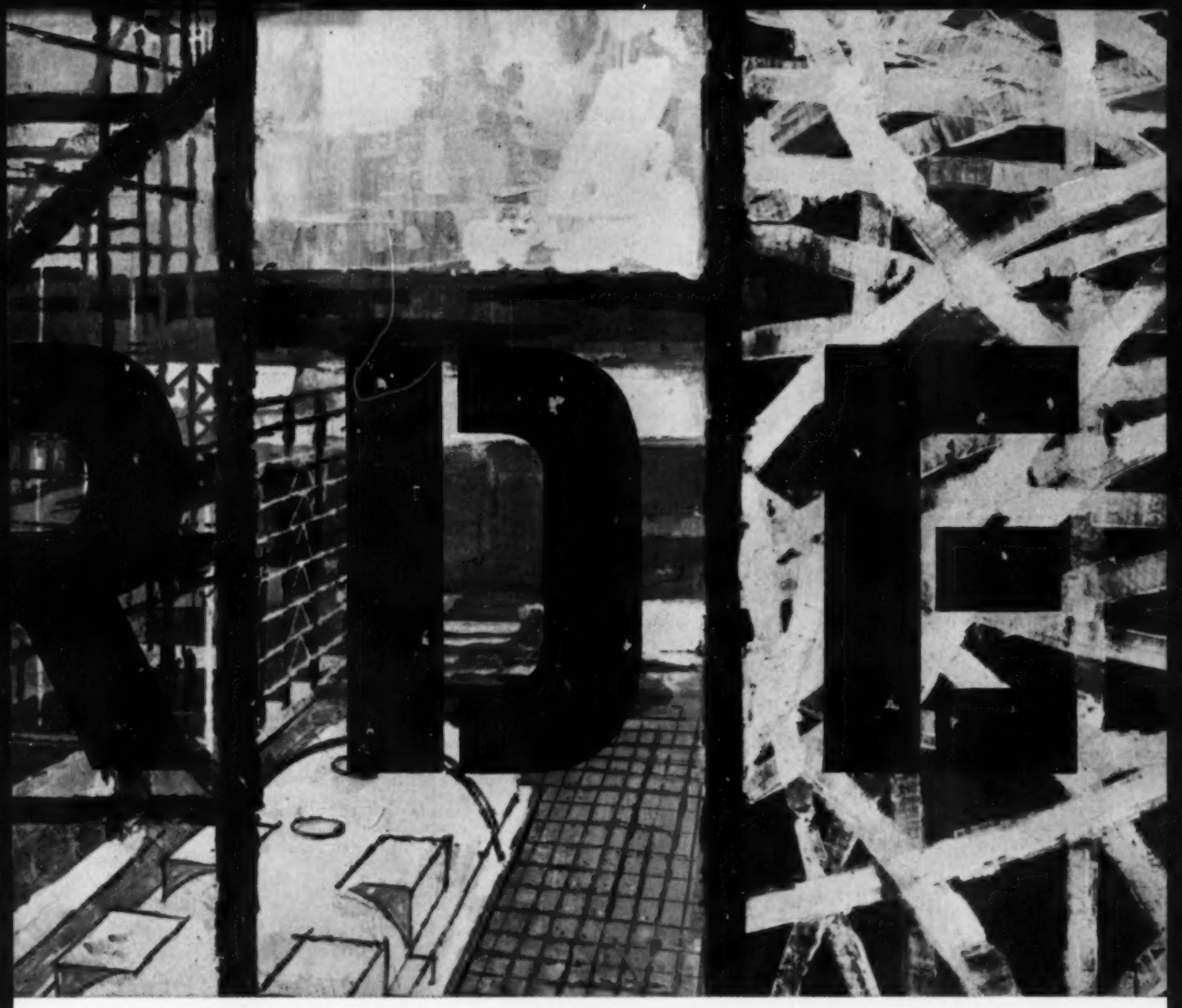
NEW GENERAL ELECTRIC COMPUTER SYSTEM

designed solely for electric utility steam power plant data processing

HERE'S HOW GENERAL ELECTRIC'S ADVANCED DESIGN SYSTEM LOWERS OPERATING AND MAINTENANCE COSTS...

GARDE is General Electric's process computer system designed especially to meet the problems and needs of electric steam plant data processing. The GARDE system gathers, alarms, reports, displays, and evaluates data from several

PCA-1



R Reports... automatically prepares a complete log of all operating conditions hourly or on demand.

D Displays... continuous visual display of any input or computed value that the operator chooses.

E Evaluates... over-all plant and key component performance hourly—or on demand.

hundred inputs located throughout the plant. It warns of abnormal deviations in those process conditions which cause equipment stress and inefficient operation. Early detection of these saves dollars in equipment maintenance and increases operating efficiency.

In addition, the GARDE system checks itself—detecting faulty sensors and other components. Its continuous reports are invaluable in periods of rapid operational changes. One of its provisions guides the operator through complex plant operating routines, helping him avoid errors and resultant equipment outage.

GARDE system evaluates these key plant operations: Boiler efficiency • Turbine Generator Heat Rate • Station Heat Rate • Correction of Heat Rates to Bogey Conditions • High Pressure and Intermediate Pressure Turbine Efficiency • Feedwater Heater and other Equipment Performance • Condenser Performance.

General Electric was able to design the GARDE system because it leads all manufacturers in process computer systems installed or ordered by the utility industry. The near-million man-hours of application and research in its design were spent in implementing systems for users. Out of this experience, came the GARDE process computer system.

Investigate this newest development in data processing for steam plants—contact your nearest General Electric Apparatus Sales Office or Process Computer Section, Industry Control Department, P.O. Box 2918, Phoenix, Arizona.

In Canada, contact Canadian General Electric Apparatus Sales Department, Peterborough, Ontario.

Outside the U.S. and Canada, contact International General Electric, 150 East 42nd Street, New York 17, New York.

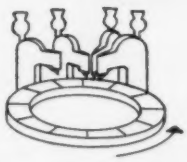
Progress Is Our Most Important Product

GENERAL ELECTRIC

Circle 662 on Page 35

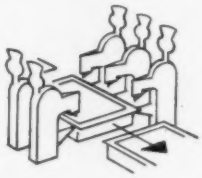
A FEW OF MANY POSSIBLE RIVETING HEAD POSITIONS THAT CAN BE USED

Rotating fixture showing suggested arrangement of riveting heads.

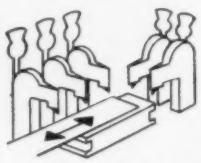


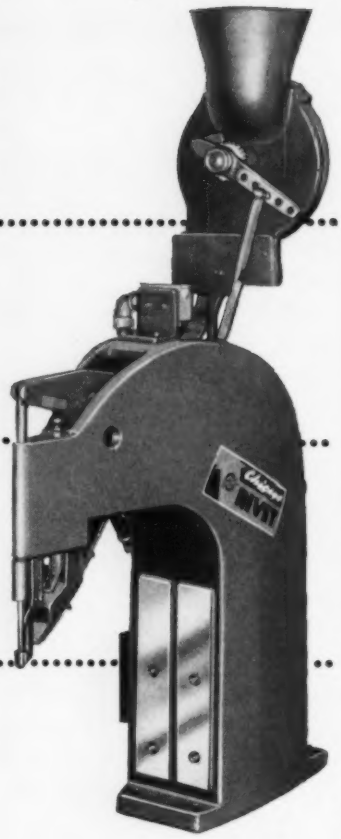
Riveting heads can be positioned for fastening on flat or curved assemblies.

Conveyor Belt permits multiple setting on both sides of an assembly.



Sliding fixture used for riveting 2 sides of an assembly.





AUTOMATE RIVET SETTING

for new low costs

For years assemblies made of metal and non-metal or a combination of both have been fastened most economically with semi-tubular rivets. And now even lower costs are possible with the thin-nose riveting heads designed by Chicago Rivet. These heads, pneumatically operated but electronically controlled, can be grouped in clusters on one or more planes and will set rivets as close as $1\frac{3}{16}$" apart. Automation, thru rotating sliding or continuous belt feeding and riveting stations, is possible. Riveting heads may be repositioned and used again on new assemblies.

CUSHIONED RIVETING REDUCES BREAKAGE

A pneumatic riveter upsets the rivet with a squeezing action which minimizes breakage and automatically compensates for slight variation in assembly thicknesses.

The suggestions of Chicago Rivet fastening specialists will prove most helpful. Call them—no obligation.

AIR-POWERED RIVETING CATALOG contains description and specifications of 8 single and multiple riveters—also rivet setters designed for automation.

RIVET CATALOG describes 1388 standard tubular and split rivets and 25 single and multiple motorized automatic rivet setters.

Chicago Rivet & MACHINE CO.

943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb) • **Branch Factory: Tyrone, Pa.**

Engineering Co. has developed such seals with stainless steel or synthetic rubber expanders. The seals need no adjustment and range in size from $\frac{1}{8}$ to 15-inch ID. In a recent test as a rod seal, there was no perceptible leakage after 400,000 cycles at 3000 psi and 400 F.

Steam Plant Control To Include Computer

CONTRACT has been let for a solid-state electronic combustion control system to be applied to the steam generator in a new 500-megawatt generating unit. Republic Flow Meters Co., subsidiary, Rockwell Mfg. Co. will supply the control system for TVA's Colbert Steam Plant Unit No. 5 at Tuscumbia, Ala.

System will include an automatic combustion control, analog instrumentation, and digital data system. TRW Computers Co., Div., Thompson Ramo Wooldridge Inc., will provide the digital data system with an RW 300 computer as part of the Republic contract for instrumentation and control of the generating station.

Transistorized, miniaturized equip-

ULTRASONIC flaw detector operates without liquid coupling to the object being tested. It is coupled to the object being tested through the medium of a newly-developed synthetic membrane which fits tightly over the transducer. The coupling membrane also serves as a protective skin to avoid damaging wear to the face of the transducer crystal caused by friction with objects being tested. Prime uses for dry-coupled flaw detectors will be for testing objects which would be damaged by liquid immersion or oil coating. They can also be used for flaw detection from irregular surfaces such as bolt-ends. Equipment is available from Circo Corp.

Bendix SYSTEM-ENGINEERED Numerical Controls log 450,000 hours—with less than 5% downtime

The impressive number of hours logged by machines operated by Bendix® numerical control systems is just one index of leadership in the new era of metalworking. Even more significant is the downtime record. Reports from 30 users show that downtime ranged from 1% to 10%, with an average of slightly less than 5%. Persuasive figures on the practicability of Bendix numerical control systems.

Bendix training and service contribute markedly to maximum machine utilization. Immediately prior to delivery of the machine tool, Bendix trains user personnel who will supervise, operate, and maintain the equipment. When the machine tool is installed, Bendix field men aid in the initial set-up. To assure quality service, Bendix maintains a competent field organization in branch offices throughout the country.

Bendix works closely with machine tool builders. And our numerical controls are *system engineered* to specific applications. Case histories prove that Bendix controlled systems cut production costs, reduce lead time, increase machine tool efficiency, and make parts of consistently high accuracy.

When you consider numerical controls—feasibility, installation, operation—call on Bendix. Investigate our complete line of control systems, both contouring and positioning. Let us explain our proved design techniques, including modular construction, transistorized plug-in circuitry, linear and rotary feedback devices, and high performance servo devices. Find out how Bendix can help you make new profits in metalworking. Write today.

BENDIX PROVIDES SYSTEMS EXPERIENCE

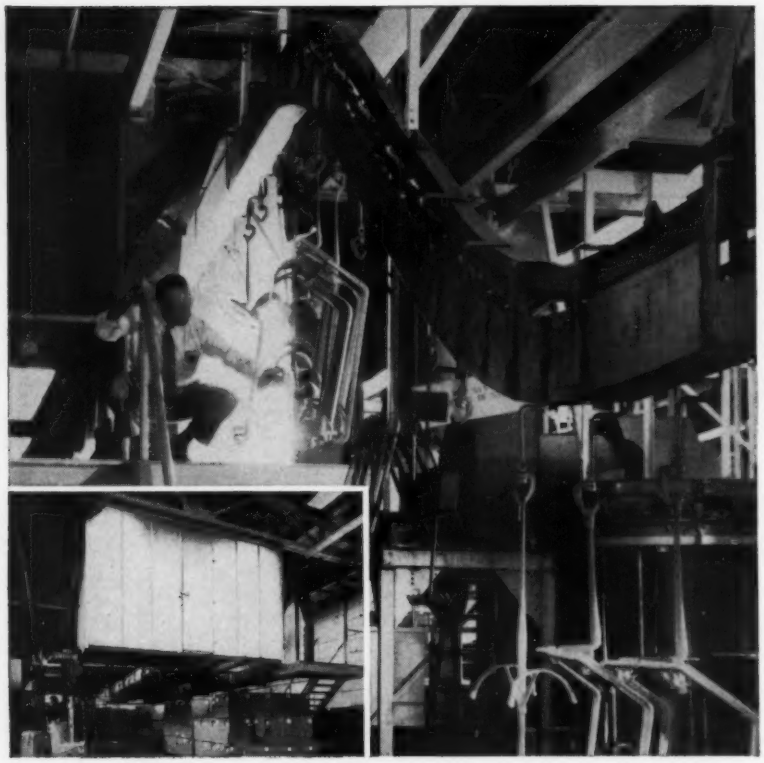
JUSTIFICATION STUDIES • SYSTEM ENGINEERING • TRAINING AND SERVICE

Industrial Controls Section

21820 Wyoming Ave., Detroit 37, Michigan

THE Bendix CORPORATION

Circle 664 on Page 35



RADCOR INFRARED OVEN

speeds baking of GM auto parts, saves floor space

When General Motors' Pontiac Division reorganized its production and assembly lines to handle the new Tempest, RADCOR engineers were on the scene to help speed baking of Dulux-coated brake and clutch pedals, gear shift levers and certain front grille components.

Pontiac put every square foot of space—on the floor and in the air—to work to maintain top efficiency. That's why a 136-foot-long, S-shaped RADCOR infrared oven was suspended from girders 20 feet above the floor to bake Pontiac and Tempest parts carried by conveyor. Space below the oven is ideal for storage and traffic. Little, if any, heat is fed into this area because of the oven's overhead position.

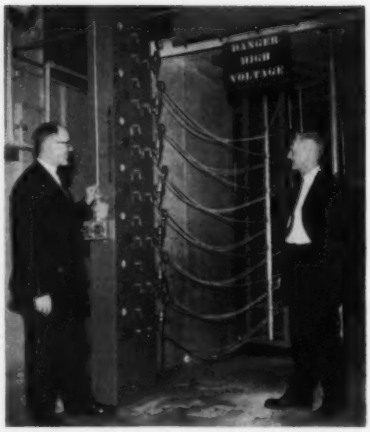
On each side of the 17 eight-foot-long RADCOR oven sections, there are five rows of eight 125-watt lamps—1,360 in all. They produce a 220 degree F. operating temperature. The oven can be controlled automatically or manually because it is linked to the control of the conveyor which snakes through the three main oven divisions. When the conveyor stops, so does baking and drying.

Like General Motors, perhaps you have an application for RADCOR's economical and efficient infrared ovens which provide the complete versatility necessary in manufacturing plants. Both custom-built and owner-erected types are available. RADCOR modular sections accommodate all practical infrared heat sources.

R-1

For more information about RADCOR infrared ovens, write for Catalog BRG100—or contact your CHROMALOX representative.

RADCOR, INC.
Bradner, Ohio
A SUBSIDIARY OF EDWIN L. WIEGAND COMPANY



ELECTROSTATIC paint spray unit for painting air conditioners was recently installed at Westinghouse Electric Corp. The system, manufactured by Ashdee Div., Atlee Corp., uses a high voltage electrostatic field to increase the efficiency of paint application. Inspecting the $30,000 unit are Allan O. Mowatt (left), president of Atlee and W. E. Petty (right), superintendent of Westinghouse's Air Conditioning Division.

ment will control coal pulverizers, fans, and feed water for the steam generator. The generator has a capacity of 3,900,000 lb per hour and operates at 2450 psi and 1053 F. The computer will scan 600 operating variables, signal off-normal operations, and print out data as required by operating personnel.

Reversing Roughing Mill Card Programmed

ELECTRICAL DRIVE and Prodac control apparatus for Acme Steel Company's reversing roughing mill at Riverdale, Ill., was supplied by Westinghouse Electric Corp. The roughing mill reduces 4½-inch thick by 30¾-foot long slabs to ⅝-inch thick steel plates for further rolling in a hot-strip finishing mill.

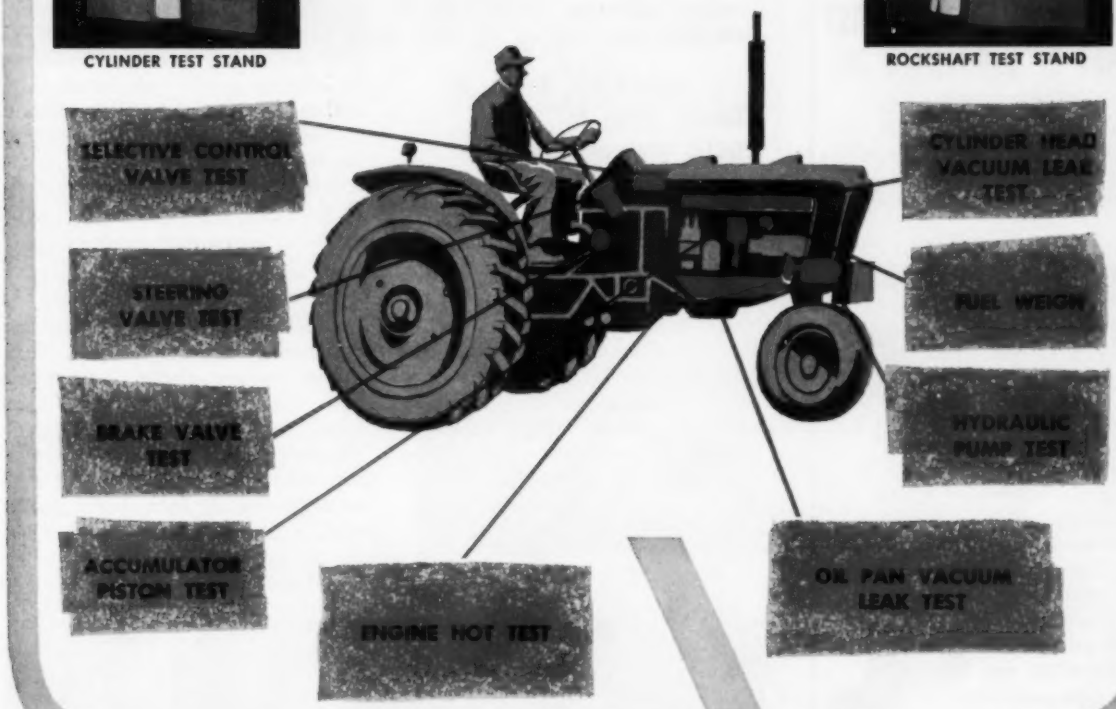
The Prodac control system automates the mill operation from a schedule recorded on a punched card. It automatically directs the horizontal roll opening, entry and delivery edger roll openings, mill and table speeds, cycle operation, draft compensation, and descaling operation. An operator can intervene and work the mill with manual controls at any point in the rolling cycle and return to automatic operation to complete the cycle.

Circle 665 on Page 35

Tested for QUALITY *by* CONTROL *Engineering Co.*

CYLINDER TEST STAND

ROCKSHAFT TEST STAND



Unified responsibility for *quality control* requirements

Any product can be made better by better testing. Control Engineering Company specializes in designing and manufacturing testing equipment . . . custom engineered to meet your specific requirements. The illustration above shows eleven important tractor parts that were tested for quality on Control Engineering test stands.

Applying new methods of testing the performability of your products will pay for themselves quickly because the field conditions under which this part must perform are duplicated in your plant. This method of inplant testing maintains top quality, provides dependable performance records and eliminates costly service and replacement.

There is hardly a manufacturing plant of any kind — including yours — where the right application of quality control methods and equipment won't produce savings many times the cost involved.

The field engineers of Control Engineering Company represent the most complete and versatile line of test equipment available through any one source, and have the real "know how" in today's modern methods of Quality Control.

CONTROL ENGINEERING COMPANY

A SUBSIDIARY OF JERVIS B. WEBB COMPANY

8007 Joy Road • Detroit 4, Michigan

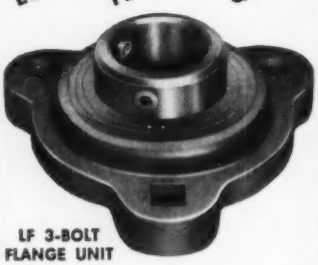
Circle 666 on Page 35

SEALMASTER

"L" SERIES

A HIGH QUALITY LINE OF MALLEABLE HOUSED BEARING UNITS AND BEARINGS AT A COST THAT IS WARRANTED ON YOUR MACHINE!

ECONOMY PERFORMANCE QUALITY



LF 3-BOLT FLANGE UNIT

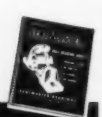
Available in pillow blocks and two or three bolt flange units for flush or recessed mounting. All units in the "L" Series available with the new SEALMASTER contact type seal.

LP PILLOW BLOCK

LF FLANGE UNIT

LFT FLANGE UNIT

WRITE FOR BULLETIN 359



SEALMASTER®

BALL BEARING UNITS

SEALMASTER BEARINGS
A DIVISION OF
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22 RIDGEWAY • AURORA, ILL.
PLANTS LOCATED IN: LOS ANGELES, CALIF. CLARKSDALE, MISS. • BELLEVILLE, ONTARIO

Circle 667 on Page 35

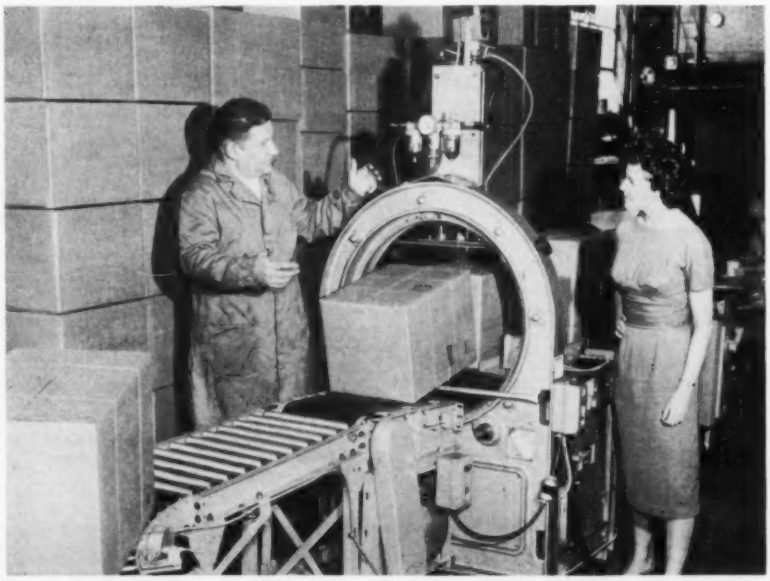
AUTOMATIC PYROMETER that continuously measures and controls extremely high temperatures has been developed by Atomics International, Div., North American Aviation Inc. These pyrometers can instantly measure and regulate temperatures to 4000 C, while recording changes to less than one degree. With attachments, the device is capable of operating in a temperature range of 10,000 C. Instrument will be manufactured by the Pyrometer Instrument Co. Inc., under a licensing agreement with North American.

Classes Given in COBOL Programming

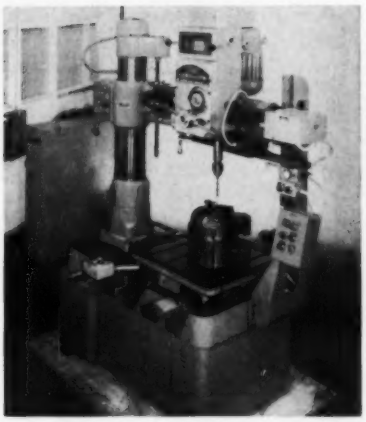
CLASSES for computer programmers have been established at the Cobol Development Center in Blue Bell, Pa., by Remington Rand Div., Sperry Rand Corp. Purpose of the classes is to instruct Univac users in the programming techniques of COBOL (Common Business Oriented Language). This technique employs English words instead of complicated machine coding. Upon completion of the training period, the students are provided with the necessary documentation and tapes for applying the new system at their own computer installations.

COLLEGE SCHOLARSHIPS amounting to $30,500 will be presented to student metals engineers by American Society for Metals' Foundation for Education and Research. Equal awards of $500, will be given to metallurgical students at 61 different participating colleges and universities throughout the United States and Canada. Winners are chosen by the schools themselves and receive a certificate in addition to the cash award. Any college or university which offers a regular academic program leading to a degree in metallurgical engineering can qualify for participation in the ASM scholarship program.

UNIFIL LOOM WINDER has been designed by Leesona Corp. for box looms running single filling yarn. This winder can be attached to a loom to automatically wind and supply yarn which is woven crosswise into the fabric. It can also be used on mills running both single shuttle and box looms.



CARTON STRAPPING line features a steel strapping machine with a photoelectric cell that scans various size cartons and adjusts itself to apply the proper number of round steel straps automatically tensioning, tying, and cutting them. Machine, designed by Supply Div., U. S. Steel Corp., is suitable for packaging such items as food products, metal parts, shingle packs, carton and wood boxes, magazines, and newspapers.

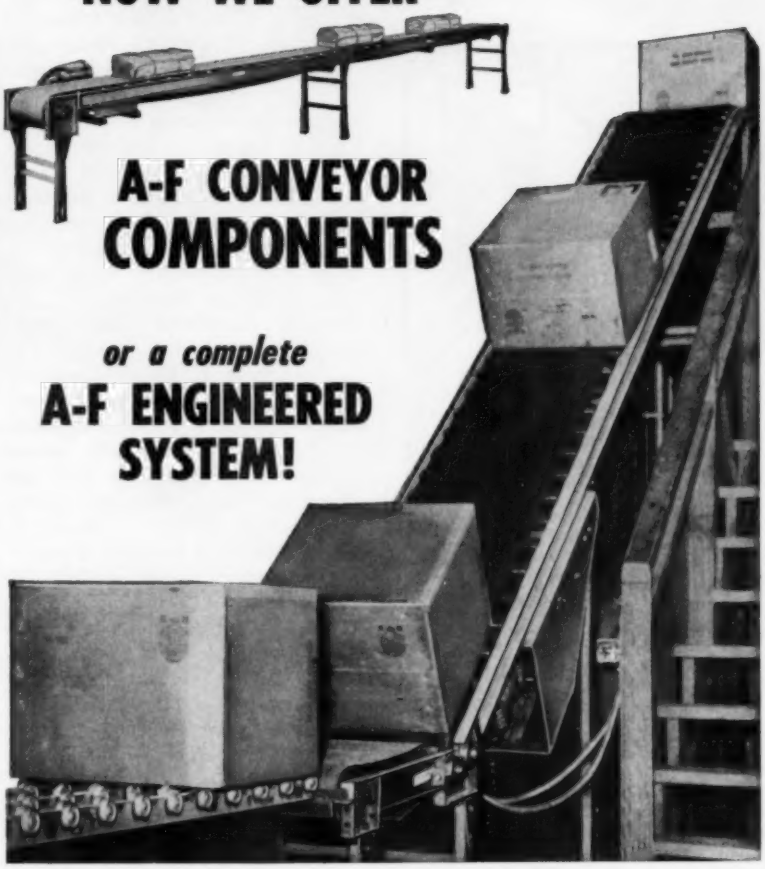


POINT-TO-POINT, two-axis positioning system has been applied to a precision radial drill built by Veet Industries Inc. The head of the machine is driven on the gantry arm to provide one axis of motion, while motion of the table supplies the second axis. Both axes can be numerically controlled by tape input to the control system supplied by Diehl Mfg. Co. The Diehl automatic positioning system is available without the Singer numerical control system, which may be added at a later date at no sacrifice of initial investment.

SPOTLIGHTING PEOPLE

C. Glen Bigelow Jr. elected vice president-research at Selas Corp. of America. . . . **G. Harding Allen** appointed works manager of the Heald Machine Co. . . . **Stephen C. Tiensch** named vice president-manufacturing at Standard Tool & Mfg. Co. . . . **Arthur Sternberg** appointed vice president and general manager of the Electrical Div., Fairbanks, Morse & Co. . . . **Frank R. Osborne** elected president of B. H. Hadley Inc. . . . **Franklin Meyer Jr.** named vice president-engineering and **Kenneth H. Williamson** appointed vice president-manufacturing, both at Taft-Peirce Mfg. Co. . . . **E. W. Wagner** named vice president and general manager of Sidney Machine Tool Co. . . . **F. W. Witzke** appointed vice president and chief administrative officer of Cleveland Instrument Co., subsidiary of Bendix Corp. . . . **Everett A. Cooper** elected vice president of Emhart Mfg. Co. . . . **Louis D. Stevens** named manager of information storage and retrieval for the Advanced Systems Development Div., International Business Machines Corp. . . . **Ervin J. Osterhus** appointed executive vice president and **Walter J. Hood** named vice president-engineering,

NOW WE OFFER



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A-F ENGINEERED SYSTEM!

YOU SAVE MANY ways with these new
A-F "E-Z Bild" Conveyor Components.
You save on low first cost . . .
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YOU SAVE EVEN MORE with a new
A-F *Engineered* plant-wide Conveying System.
Automatic loading and un-loading devices.
Automatic counting and shunting of components,
products, cartons, cases—to proper production areas,
storage, accumulating or shipping lines.
. . . . many other new automated devices—if needed.

Before you order a single conveyor or a complete conveyor system
Why not discuss the matter with one of our sales engineers?
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A-F Conveyors

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"Build-It-Yourself" Conveyors
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FIRST . . . IN MEASUREMENT AND CONTROL OF MATERIALS FLOW

Is messy carbon feeding giving you a headache? Costly housekeeping and employee health problems cutting your profits?

Whether you're feeding floodable carbon (smoke) or free flowing granular carbon, B-I-F's totally enclosed feeding systems provide automatic, continuous control of the flow of this hard-to-handle material . . . at high accuracy. Regardless of material characteristics or process conditions, B-I-F has the performance-proved, engineered system for more efficient carbon feeding.

Free Facts

Continuous feeding/blending saves material, reduces costs, controls quality . . . results in bigger processing profits. Write for the Facts today!

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Circle 669 on Page 35

both at Designers for Industry Inc. . . . **Charles M. Hargraves** appointed manager of the Industrial Equipment Div., R. C. Mahon Co. . . . **D. H. Brandon** named director of programming services for John Diebold & Associates Inc. . . . **William E. Durnan** appointed executive vice president of Bijur Lubricating Corp. . . . **Kenneth B. Smith** named manager of the Fabrication Dept., Spaulding Fibre Co. Inc. . . . **D. E. Stoner** appointed works manager of Landis Machine Co. . . . **Keith T. Middleton** elected president of the Fafnir Bearing Co. . . . **William E. Bacon** appointed administrative assistant to the president of Hancock Telecontrol Corp. . . . **Pierce Hollingsworth** named manager of engineering and development, Automotives Div., Standard-Thomson Corp. . . . **Erich A. Herold** appointed manager of manufacturing planning at Sanders Associates Inc. . . . **Harvey L. Cook Jr.** named vice president in charge of engineering and production, **Theodore W. Helweg** appointed vice president in charge of sales, and **Milton J. Grossman** named vice president in charge of administration, all at Farrington Electronics Inc. . . . **Albert Kluge** joined Planet Corp. as project engineer for automated foundry materials handling equipment. . . . **Warren S. Wilkinson** elected president of Hanson-Van Winkle-Munning Co. . . . **Charles H. Doersam** appointed product development manager in engineering at Potter Instrument Co. Inc. . . . **Allan B. Chirgwin** named chief engineer of Farrel-Birmingham Co. Inc. . . . **John D. Gum** appointed director of engineering for Photo-Optical Div., Consolidated Systems Corp.

SPOTLIGHTING PLANTS

Giannini Controls Corp. has entered into an agreement to acquire Cramer Controls Corp., subject to approval of Cramer's stockholders. . . . **Control Data Corp.** has selected a 31-acre site in East Industrial Park, Bloomington, Minn., as the location of its new Corporate and Computer Div. headquarters. A 100,000 sq ft building will be erected on the site by late this year. . . . **Gulton Industries Inc.** has formed a Scanner Systems Group to develop electro-optical scanning systems for measurement, control, and display. . . . **Lanston Industries Inc.** has acquired manufacturing and marketing rights for two automated counting devices—the Tally-Tab 1000, an automatic

ZONE PASTEURIZER-COOLER also cleans and drys glass, metal, or plastic containers filled with food, drug, cosmetic, and beverage products. Developed by Standard Metal Products Co., the unit consists of three zones. In the first zone, the containers are cooked or pasteurized by steam or high temperature water from above and below. By means of a conveyor they move into the cooling zone where they are washed by a fine mist from overhead atomizer sprays. Third zone is the drying zone where the containers are sparkle-dried by air blown from different angles. Dry containers are discharged to the take-away conveyor, ready for labeling.

NOW...

*1½" to 8" bores

There's an O-M Cylinder for Every Purpose

Meet JIC Standards

With the introduction of the new O-M Series "K," Square Head Air Cylinder, we can now supply the right air or hydraulic cylinders for your specific applications on low or high pressure systems. Ruggedly constructed of the highest quality materials, accurately machined to close assembly tolerances, O-M Cylinders operate with high efficiency and are quickly and easily maintained.

Whether your spec's call for a cylinder for a single operation or a variety of cylinders for a sequence of operations under continuous automatic cycling, there is an O-M Cylinder to meet your requirements. O-M Cylinders are individually tested at the factory and are available with standard or oversized rods, completely interchangeable parts and mounts.

Mail coupon TODAY for latest Bulletins showing construction and dimensional details, engineering drawings, capacity chart and mounting data.

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COMPANY_____

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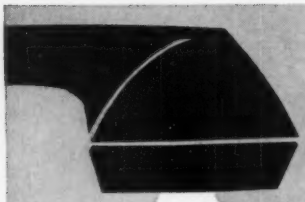
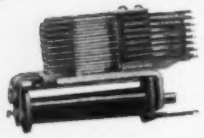
Circle 670 on Page 35



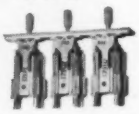
WHEN QUALITY IS A MUST

Stromberg-Carlson®

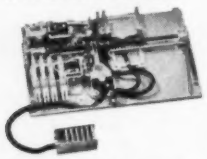
TELEPHONE-TYPE COMPONENTS



RELAYS: Wide range, for electro-mechanical switching. Send for Bulletin T-5000R2.



KEYS: Cam-type and push-button. Send for Bulletin T-5002R.



STEPPING SWITCHES. Fast and dependable. Bulletin T-5001R.

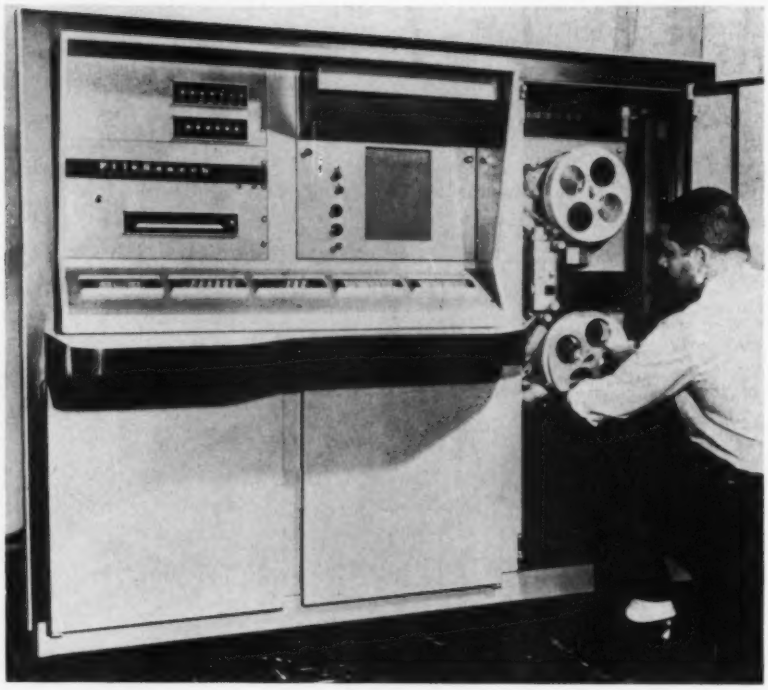
JACKS & PLUGS: For many electrical and electronic uses. Send for Bulletin T-5003.

TELEPHONE HANDSETS: Standard or with switch assemblies. Send for Bulletin T-5005.

For bulletins and more information contact the nearest Sales Branch office: Atlanta—750 Ponce de Leon Place N.E.; Chicago—564 W. Adams Street; Kansas City (Mo.)—2017 Grand Avenue; Rochester—1040 University Avenue; San Francisco—1805 Rollins Road.

GENERAL DYNAMICS / ELECTRONICS

Circle 671 on Page 35



MACHINE which automatically stores and retrieves information on microfilm reels at a rate of 6400 magazine pages a minute, has been developed by FMA Inc. The system can store 32,000 standard-sized magazine pages on a single reel of microfilm and can accommodate over 1,600,000 pages of information in a single file cabinet. When information is required, requests are fed into the machine by punched cards. The machine automatically searches the microfilm reels at the rate of 6400 pages a minute, projecting desired pages for viewing or making copies of the requested material.

counter and tab inserter; and Countron, a predetermined counter —from Miller-Lauffer Printing Equipment Corp. . . . **Fluid Controls Inc.** is constructing a new headquarters building in Mentor, Ohio. . . . **COMCO Corp.** is the name of a new company formed to manufacture materials classification and conveying equipment. . . . **Fansteel Metallurgical Corp.** has contracted to acquire Wesson Tool Co. . . . **Operations Research Inc.** is constructing a new 5-story building in Silver Spring, Md. . . . **Flo-Tronics Inc.** has acquired the assets of Kenco Plastics. . . . **Lovelace, Lawrence and Co. Inc.** is the name of a recently formed consulting and design service for industrial classification and coding, standardization and simplification, and information storage and retrieval. . . . **Ovitron Corp.** has acquired Standard Winding Co., manufacturer of electronic components for communications and home entertainment markets. . . . **General Electric Co.** will make a $750,000 expansion in its phenolic molding compound plant in Pittsfield, Mass. The investment will increase plant capacity about 30 per cent. Installation of new equipment will begin late this year and will be operational in 1962. . . . **International Telephone and Telegraph Corp.** has acquired Surprenant Mfg. Co., producer of high-test insulated wire and cable products.

MEETINGS AND EVENTS

June 4-9—

Society of Automotive Engineers. Annual summer meeting to be held Chase-Park Plaza Hotel, St. Louis. Information available from society headquarters, 485 Lexington Ave., New York 17, N. Y.

June 5-8—

Eastern Seaboard Apprenticeship Conference. Cosponsored by Bureau of Apprenticeship and Training of U. S. Dept. of Labor with other groups. To be held Equinox House, Manchester, Vt. More information available from Bureau of

Apprenticeship and Training, U. S. Dept. of Labor, Washington 25, D. C.

June 5-9—

Society of the Plastics Industry. National plastics exposition and conference to be held the New York Coliseum and Commodore Hotel, New York City. More information from society headquarters, 250 Park Ave., New York 17, N. Y.

June 6-8—

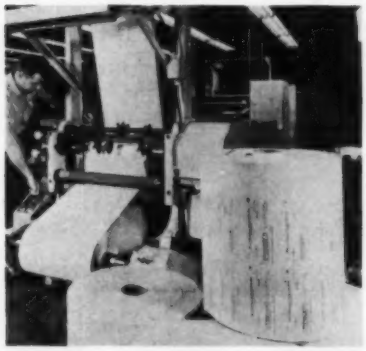
International Instrument-Automation Conference and Exhibit. Sponsored by Instrument Society of America. Conference to be held Royal York Hotel and exhibit to be held at Queen Elizabeth Building, Exhibition Park, Toronto, Canada. More information available from society headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

June 8-10—

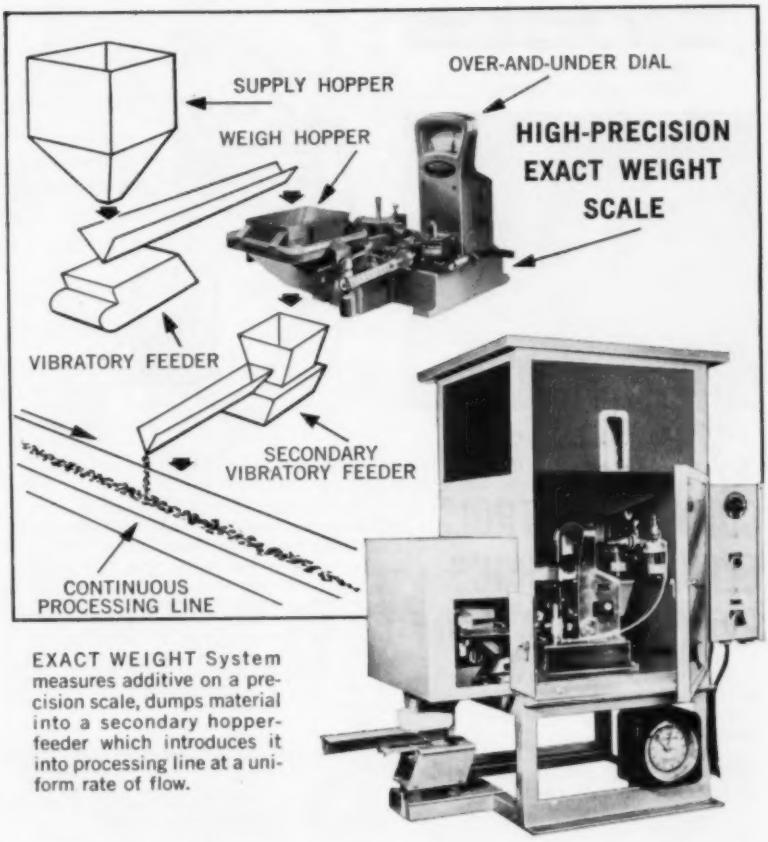
Manufacturing Chemists' Association. Annual meeting to be held at the Greenbrier, White Sulphur Springs, W. Va. More information available from association headquarters, 1825 Conn. Ave., N.W., Washington 9, D. C.

June 11-15—

American Society of Mechanical Engineers. Summer annual meeting to be held Statler Hilton Hotel, Los Angeles. Additional information



PAPER CHECKS, imprinted with magnetic ink for automated handling, are now being manufactured by International Business Machines Corp. They are available in continuous forms and unit sets in a wide variety of colors and styles. Gilbert E. Jones, president of IBM's Data Processing Div., which will market the checks, expects that more than 80 per cent of all checks in circulation in this country by 1964 will be magnetically imprinted for electronic data processing.



EXACT WEIGHT System measures additive on a precision scale, dumps material into a secondary hopper-feeder which introduces it into processing line at a uniform rate of flow.

EXACT WEIGHT® CONTINUOUS WEIGHER inserts additives in precise amounts

This Exact Weight Continuous Weigher inserts loose, free-flowing granular solids into processing lines in exacting quantities. Accurately-timed feeding of material over a given period of time assures controlled integration into the processing stream.

Exact Weight machines of this type are currently being used in the processing operations of foods, chemicals and pharmaceuticals. Machines are fully enclosed for protection against contamination. Models are available in a range of capacities from one gram to 300 pounds.

Exact Weight equipment is backed by more than 45 years of experience in building job-engineered scales for all types of applications. We offer experienced counsel and factual data on the best method for weighing your product. For complete information on the Exact Weight Continuous Weigher, request Bulletin 3311.

Exact Weight SCALES

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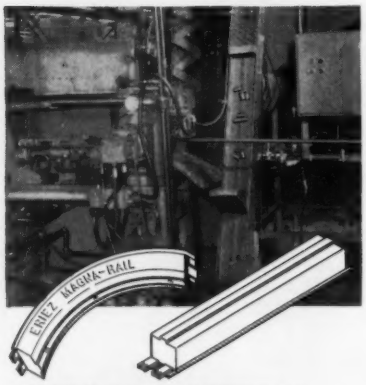
BETTER QUALITY CONTROL . . . BETTER COST CONTROL

Circle 672 on Page 35

ERIEZ *Magnetic Minute*

60 seconds that will help you improve operating efficiency.



CONVEY, CONTROL, ELEVATE FERROUS PARTS faster...safer

Do it magnetically . . . with MAGNA-RAILS — from the Eriez line of Magnamation® (magnetic automation) components.

Powerful magnetic action holds items ranging from tiny tacks to large finished parts at fast speeds, up or down inclines as steep as 90°. You can convey on top **and** bottom sides of your lines; turn parts over automatically; change direction of flow, etc.

Use of steep inclines shortens belt spans, permits close grouping of machines to conserve valuable floor space. Positive hold prevents slippage of parts — reduces damage, cuts need for manual handling, increases safety.

Eriez field engineers will gladly show you exactly how MAGNA-RAILS help you move materials faster, safer, more economically, more efficiently . . . either on new or existing lines. Write to:

ERIEZ MANUFACTURING CO.
119TA Magnet Drive, Erie, Pa.

MAGNA-THOUGHT

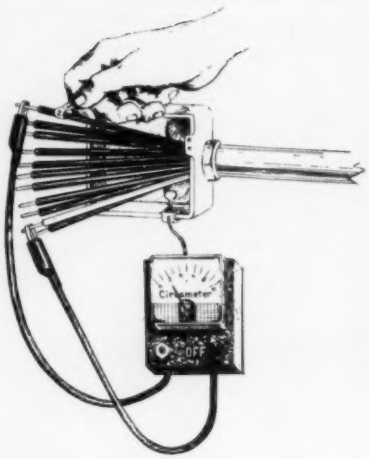
By using exactly the right magnetic material for a given application, Eriez can provide each customer with precisely the right equipment to do a particular job.

W. J. FALLER
Product Mgr. Automation

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 673 on Page 35



IDENTIFYING WIRES in conduit raceways is the function of a Circameter designed by Products for Industry. The meter can also be used in continuity testing and in research and development projects where continuous testing of wires, cables, and harnesses are required. This method eliminates errors and facilitates testing of wires to meet building codes and blue-print specifications in the field, production, or maintenance.

from society headquarters, 29 W. 39th St., New York 18, N. Y.

June 13-16—

International Symposium on Gas Chromatography. Sponsored by Instrument Society of America. To be held Michigan State University, East Lansing, Mich. Additional information available from society headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

June 14-15—

National Conference on Product Engineering and Production. Sponsored by Institute of Radio Engineers. To be held Sheraton Hotel, Philadelphia. Details available from institute headquarters, 1 East 79th St., New York 21, N. Y.

June 18-23—

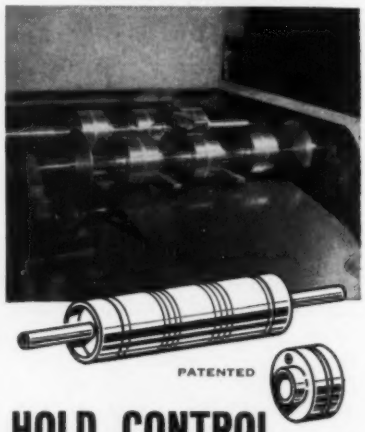
American Institute of Electrical Engineers. Summer general meeting scheduled at Cornell University, Ithaca, N. Y. Details available from institute headquarters, 33 West 39th St., New York 18, N. Y.

June 21-23—

American Association of Cost Engineers. Annual meeting to be held Somerset Hotel, Boston. Information available from E. D. Shanken, Ex-

ERIEZ *Magnetic Minute*

60 seconds that will help you improve operating efficiency.



PATENTED

HOLD, CONTROL, ELEVATE, CARRY

ferrous materials magnetically

Do it with MAGNA-ROLLS — from the Eriez line of Magnamation® (permanent magnetic automation) components. They're particularly valuable in speeding and simplifying sheet handling.

Use Magna-Rolls as magnetic head pulleys to carry ferrous materials up and over or down and under belt conveyor lines. Use them singly or in multiples for feeding, conveying and controlling parts on non-belt systems. As magnetic feeders to control and feed sheets, blanks and formed parts to various operations, and many other ways too!

Magna-Rolls can be furnished in diameters ranging from 2½" to 30". Erium® powered magnetic strengths and field depths can be furnished to meet specific requirements. In the wide range of standard and modified standard units you will almost certainly find a simple, economical solution to your specific handling or conveying problems.

Full data on Eriez Magnamation components is available in our newest Bulletin. Write for it to:

ERIEZ MANUFACTURING CO.
119TB Magnet Drive, Erie, Pa.

MAGNA-THOUGHT

Most of the very first installations of Eriez equipment are performing as effectively today as they did when they were new, years ago.

A. F. ISRAELSON
Chief Engineer

ERIEZ

A GROWTH COMPANY . . .
10 NEW PRODUCTS IN THE LAST 5 YEARS

Circle 674 on Page 35

ecutive Secretary AACE, University of New Hampshire, Durham, N. H.

June 21-23—

American Institute of Electrical Engineers. Pulp and paper conference scheduled for Kalamazoo, Mich. Details available from institute headquarters, 33 West 39th St., New York 18, N. Y.

June 25-30—

American Society for Testing Materials. Annual meeting will be held Chalfonte-Haddon Hall, Atlantic City, N. J. Information available from society headquarters, 1916 Race St., Philadelphia 3, Pa.

June 26-27—

Conference on Vacuum Metallurgy. Fifth annual conference cosponsored by American Vacuum Society and New York University. To be held at University Heights Campus of New York University. Additional details available from society headquarters, Box 1282, Boston 9, Mass.

June 28-30—

Joint Automatic Control Conference. Sponsored jointly by AIChE, AIEE, ASME, IRE, and ISA and scheduled at the University of Colorado, Boulder, Colo. Details are available from Instrument Society of America, 313 Sixth Ave., Pittsburgh 22, Pa.

"It may be a typographical error to you, but I've got a hundred thousand of these."

INFRARED

IN...ON...OVER...UNDER...AROUND—FOSTORIA OVENS BAKE FINISHES FAST REGARDLESS OF PRODUCT SHAPE

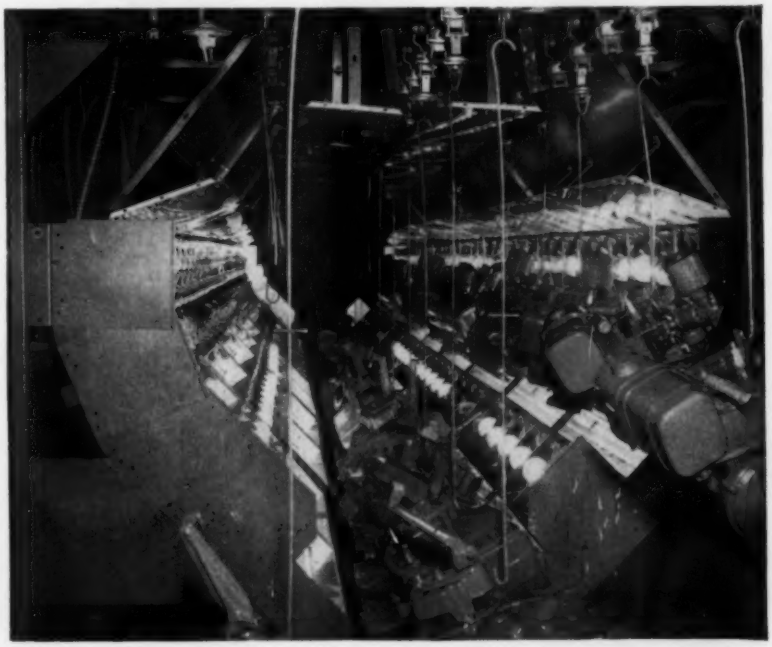
Irregular product contours and varying metal thicknesses make it tough to properly bake enamel finishes uniformly. Runs, soft spots, thin spots and over baking are commonplace, resulting in poor appearance and customer dissatisfaction. But Clinton Engines Corporation of Maquoketa, Iowa and Clinton, Michigan have solved the problem with the pictured installation of Fostoria Infrared Drying Ovens.

Because Fostoria Infrared ovens are designed to direct heat to all surfaces evenly and quickly, Clinton engineers find 50% fewer rejects due to improper finishing. In addition, they have cut drying time by 50%. They are saving 15% on paint material costs.

As though this weren't enough, they are finding equally successful results on such diversely shaped products as engines, chain saws and outboard motors.

Damage, due to production line stoppage, has been practically eliminated because, in contrast to hot air equipment, infrared heat peaks and shuts off almost instantly.

This is only part of the story. Innumerable progressive manufacturers in such diverse industries as metalworking, wood, paper, textiles, food and many others are using Fostoria Infrared Ovens to bake, dry, cook, dehydrate, and perform other heat processing applications—in short to produce better products at lower cost. Case histories are available to you without charge. Write today, giving a brief description of your type of manufacturing and we'll send pertinent information as to how Infrared can benefit you.



FOSTORIA

INFRARED DIVISION • FOSTORIA CORPORATION • FOSTORIA, OHIO

Circle 675 on Page 35

new–lube-free...

STERLING
Sealed and shielded bearings require no lubrication.
Keys are fabricated from tough elastic material to eliminate key and keyway wear.
Wear-resistant non-metallic bushings require no lubrication.
Shaft surfaces are corrosion-proof and require no lubrication.
CAUTION

...Sterling's variable speed drive never requires lubrication

Costs Reduced—One of management's biggest headaches has been the development and maintenance of proper lubrication schedules. As a consequence, lubrication problems have long been the cause of variable speed drive failures, pulley wear, sticky pulleys, shortened belt life, excessive noise, and many other equally costly problems.

High labor costs, coupled with increased maintenance needs, are major management problems.

Lubrication Eliminated—Now, Sterling has eliminated all lubrication maintenance problems. No part of a Sterling variable speed drive needs to be lubricated.

All bearings, sealed and shielded, are factory-lubricated and therefore require no lubrication. Shaft surfaces are impregnated with a special exceptionally tough and wear-resistant material which eliminates need for lubrication. The non-metallic bushings are also fabricated from a special material that is equally wear-resistant.

Special Load-Bearing Surfaces—At no time do these surfaces require any attention. Even the keys are fabricated from a tough elastic material and will not wear out.

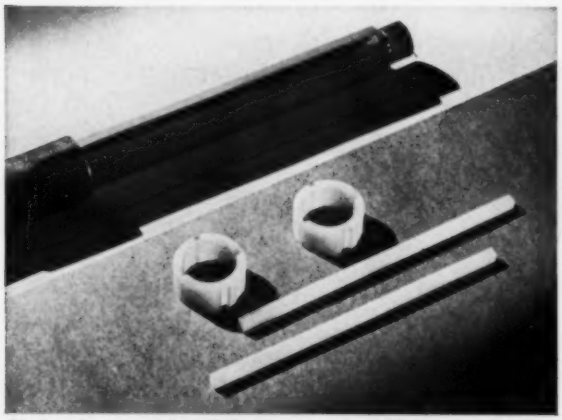
Fret corrosion, long a problem with metallic load-bearing surfaces, is completely eliminated since non-metallic surfaces now carry the load. Sticky pulleys, frequently the result of improper lubrication, are no longer a problem.

Sterling's new "Lube-Free" variable speed drive can be installed in any location, no matter how inaccessible, since lubrication maintenance is no longer needed.

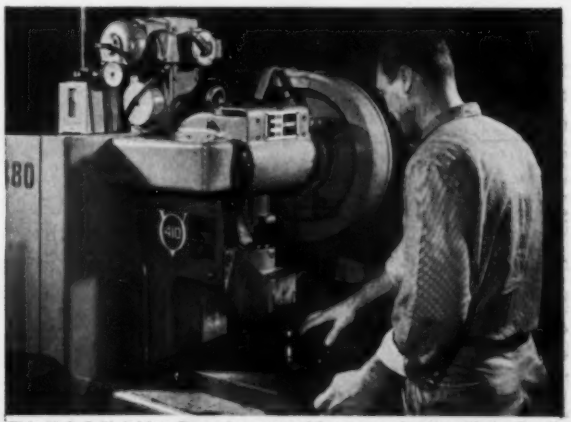
Other Benefits—Costs are reduced, money saved, when lubrication maintenance is no longer necessary. Belt life is lengthened; pulley wear is eliminated. Bearing life may also be lengthened by the elimination of worn pulleys—often the cause of vibration and bearing wear.

All other Sterling variable speed advantages are present in this new "Lube-Free" drive: wide range of speeds, heavy duty cast iron case, finger-tip speed control, etc.

Information Available—Complete application and product information is available by writing Dept. D-2, Sterling Electric Motors, Inc., 5401 Telegraph Road, Los Angeles 22, California—or by contacting the Sterling field engineer in your area.



Shaft surfaces are extremely tough; material provides unusual chemical resistance and anti-frictional properties that make an excellent load-bearing material operating under extremely low or high temperatures. Keys and bushings are fabricated from a material proven to have outstanding abrasion resistance; holds up indefinitely under frictional conditions, thus eliminating need for lubrication.



This V & O Notching Press is powered by a new Sterling "Lube-Free" variable speed drive. It will never need lubrication. Similar units have been installed in the food processing industry. The elimination of lubrication is particularly important in the food processing industry where variable speed drives have such wide application, and where oil and grease create sanitation problems.

Hathaway INSTRUMENTS INC.

Sterling Electric Motors, Inc.

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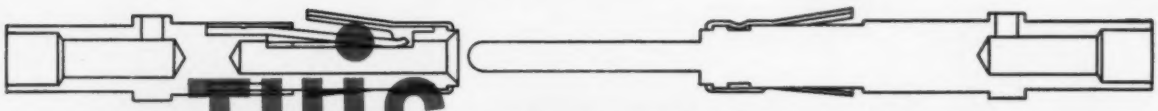
Circle 676 on Page 35

IN RACK AND PANEL CONNECTORS



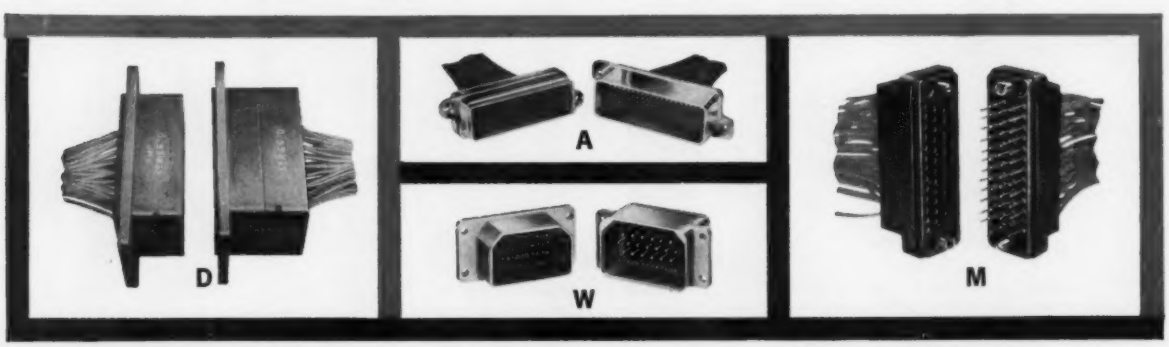
THIS MAKES THE DIFFERENCE!

Right here in the socket contact lies the heart of the **AMPin-cert Connector** line: the AMP cantilever spring. Seated in the slot of the socket to meet the pin shaft, it is your key to top connector reliability.

It provides you with positive wiping action . . . consistently sound electrical contact . . . firm pin grip . . . and stable resistance—yet has an extremely low, uniform insertion and withdrawal force. And, regardless of the metal plating you choose or the thickness you require, all pins and sockets are provided with an underplating of nickel to give long life reliability in all critical applications.

Add to this cantilever construction, many other plus features including AMP's industry proven solderless crimping technique to help you design and manufacture products of the highest reliability and lowest cost.

Take your pick: **AMPin-cert Connectors** in Series D, M and W as well as environmentally sealed or unsealed Series A—all tough enough to soak up heavy punishment while providing the dry circuit sensitivity you need for your most critical applications.



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Circle 677 on Page 35

around the triangle

METER SCALES AUTOMATICALLY SHIFTED

Tachometer with scales that are automatically changed by a speed detecting switch has been announced by Torq Engineered Products Inc. The 2-scale meter is automatically switched from the 0-1000 to the 0-4000 rpm scale with a speed detector. Two different color-coded dial lamps are wired into the circuit for visual determination of the operating scale. Control device of the unit is a rotary centrifugal switch, mounted directly on the tachometer shaft, in conjunction with a matching stationary switch. The scale switching circuit is used in an automobile distributor testing installation.

TWO-STATE CONTROL SYSTEM

Automatic dispatching system, manufactured by General Electric Co., will be installed in the Southwestern Public Service Co., Amarillo, Tex., to control six turbine-generators in three steam generating plants located in two states. Plants tied together by the system will include Plant X, three turbine-generators; Nichols Station, two turbine-generators; both plants located in Texas; and Cunningham Station, one turbine-generator located in New Mexico. Cost of the system will be approximately $100,000. Besides using the system to control the turbine-generators, SPS will feed the equipment data on what is being done at other generating plants in its operating territory.

MAIL HANDLING IMPROVEMENTS SOUGHT

Improvements in machinery to handle the increasing volume of mail are being sought by the Post Office Department. Postmaster General J. Edward Day has offered industry a challenge by outlining several projects. These projects include: A durable machine to read, face, and sort mail by chemical or electronic operation; flexible and variable stamp dispensing equipment; a basic machine to sort mail by states; and mail boxes which will stack letters as they are dropped in. Improvements such as these would have application not only in thousands of post offices, but also in offices where close co-operation with the post office in preparation of mail in bulk is a must.

CONVERTS ADDRESS LISTS TO COMPUTER LANGUAGE

Converting Addressograph plate impressions to electronic data processing language is a service to be supplied by Rabinow Engineering Co. Inc. A universal reader which automatically reads Addressograph plate impressions and simultaneously converts them to EDP language is now being assembled. The reader will electronically read all existing metal address plate fonts at a rate of six or more lines per second. It will then accurately code this information on any conventional EDP inputs such as punched paper tape, magnetic tape, or punched cards. Initially, only metal address plates will be converted, but it is expected that this operation will eventually be expanded to include address lists now on spirit duplicating or other masters.

MACHINING FOR MORE COMPONENTS PER INCH

Electron-beam-activated machining method for film materials used in electronic data processing systems has been developed for the U. S. Navy, Office of Naval Research. The process employs an active element based on the mechanical tunneling of electrons from a metal into a high vacuum. In fabricating film materials, the micromachining method uses an electron beam to form a chemically resistant film on the material being machined, which is subsequently etched in vacuum by a molecular beam. The technique has resolution capabilities of several hundred angstrom units and handles electronically clean materials with minimum contamination. The technique may eventually allow economical production of data systems with 10" active components in one cubic inch.

Information Service

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INDEX OF EQUIPMENT BY ITEM NUMBERS

(New Equipment, New Components, and New Literature covered in this issue)

Adjustable speed drives, 505
Air regulator, 460
Amplifiers
  magnetic, 463
  mechanical power, 496
Analog converter, 459
Analyzer, rotational, 439
Assembly machine, 417

Belts
  conveyor, 477
  drive, 477
Boring machine, gun, 423
Brake, electromagnetic, 435

Cameras, 509
Carton former, 419
Checkweigher, in-line, 420
Chucking automatics, 497
Circuit tester, 413
Classifiers, diode, 431
Clocks, digital, 466
Clutch/hub assemblies, 453
Clutches, hydraulic, 450
Computers
  analog, 425
  digital, 425
Control meter, electronic, 452
Controllers, multipoint, 482
Controls
  electronic, 498
  indicator light, 462
  level detection, 498
  malfunction, 498
  numerical, 492
  pressure, 442
  rectifiers, 511
  rotary kiln, 507
  temperature, 437
Converter
  analog, 459
  tape, 427
Conveyor belt booster, 415
Conveyor drive, screw, 465
Conveyors
  bulk handling, 474
  sorting, 491
Cutting machine, glass, 411
Cylinders, 449

Data processing, 487
  analog converters, 459
  code converter, 427
  computer format recorder, 502
  digital clocks, 466
  linkage system, 425
  memory core tester, 409
  oscillograph, 403
  point-to-point positioner, 471
  reader, 469
  readout, 444
  tape reader, 418
  writing machine, 418
Decade module, 434
Digital
  clocks, 466
  extensometer, 402
  readout, 444
Diode testers, 431
Drives
  adjustable speed, 505
  generators, 500
  screw conveyor, 465
  shaft speed reducer, 447

Dryers, back, 494
Drying equipment, high vacuum, 501

Electrical components, 433, 436, 438, 456, 463, 464, 468, 478, 488, 490, 493, 496
Electromagnetic
  brake, 435
  clutch/hub assemblies, 453
Extensometer, digital, 402

Feeder, 426
Feeds
  drill press, 404
  punch press air, 428
Filler, rotary, 406
Finishing processes, barrel, 483
Fitting
  four-seal, 440
  tube, 454
Flaring machine, 411
Flowmeter, 445
Fluid power applications, 485
Forming machine
  carton, 419
  metal, 422
Forming process, cold, 489
Furnaces
  conveyor muffle, 470
  high vacuum, 501
  hydrogen atmosphere, 414

Generators, 500
Grinders, 410
Gun boring machine, 423

Handling
  bulk conveyor, 474
  conveyor belts, 477
  conveyor booster unit, 415
  drill press feeds, 404
  feeder, 426
  punch press feed, 428
  sorting conveyor, 491
  stacker, 426
Handling devices, component, 508
Handling systems, overhead, 484
Handling units, magnetic, 499
Heating equipment, electrical, 504
Hydraulic clutches, 450
Hydraulic components, 480

Impact hammer, 429
Indexing machine chassis, 506
Indicator light, 462
Inspection device, yarn, 451
Instruments controls, 439, 443, 451, 460, 476, 482, 510
Integrator, chart, 476

Kiln controls, rotary, 507

Lathes, 467
Light, indicator, 462
Limit switches, 438, 464, 468
Linkage system, computer, 425

Machine chassis, indexing, 506
Machine tool attachments
  mandrels, 472
Machine tools
  boring, 423
  chucking, 497
  cutting, 411
  grinder, 410
  hydraulic press, 412
  lathes, 467
  milling, 479
  pin press, 405
  resistor spiralling machine, 416
  transfer presses, 407
  web shearing lines, 481
Machines
  assembly, 417
  dryers, 494
  finishing, 430
  forming, 422, 489
  furnaces, 414, 470
  impact vacuum, 429
  lead straighteners, 408
  lead straightening, 424
  solder, 401
  strapping, 486
  taping, 424
  welding, 421, 473
Magnetic amplifiers, 463
Magnetic memory core tester, 409
Measuring
  control meter, 452
  dew point transducer, 451
  extensometer, 402
  flowmeter, 445
  force transducer, 455
  liquid metering equipment, 432
  pressure control, 442
  pressure indicator, 495
  temperature controls, 437
  transducer-analyzer, 439
Metering equipment, liquid, 432
Microstoning machine, 430
Milling machine, 479
Module, decade, 434
Monitoring system, electronic, 510
Motors
  gear, 490
  synchronous, 433

Numerical control
  system, 492
  positioner, 471

Oscillograph, 403
Overhead handling systems, 484

Packaging
  carton forming machine, 419
  filler, 406
Pneumatic components, 441, 445, 457
Presses
  broaching, 412
  forming, 412
  hydraulic, 412
  pin, 405
  transfer, 407

Pressure control, 442
Pressure indicator, 495
Pumps
  high vacuum, 501
  vane, 446
Punch press air feed, 428
Punched card switch, 456

Reader, card, 469
Readout, digital, 444
Recorder, computer format, 502
Recording instruments, 509
Regulator, air, 460
Relays
  general purpose, 493
  midget stepping, 436
Resolvers, 488
Riveter head, 458

Shearing lines, web, 481
Solder machine, dip, 401
Speed drives, adjustable, 505
Speed reducers, shaft, 447
Spiralling machine, film resistor, 416
Stacker, 426
Stepping relay, midget, 436
Straightener, lead, 408
Straightening machine, lead, 424
Strapping machines, compression, 486
Switches
  door interlock, 478
  limit, 438, 464, 468
  punched card, 456
  safety, 468
Synchronous motor, 433
Synchros, 488

Taping machine, 424
Temperature controls, 437
Templates, drafting, 475
Testers
  diodes, 431
  electronic circuit, 413
  memory core, 490
Timer cam, 443
Tracer-controlled forming machine, 422
Transducer-analyzer, 439
Transducers
  dew point, 451
  force, 455
Translator, tape, 427
Triggers, magnetic, 511
Tube fitting, 454

Valve monitoring system, 448
Valves
  high vacuum, 501
  hydraulic relif, 480
  pneumatic, 441, 457
Vane pumps, 446

Web shearing lines, 481
Weighing, 420
Welders, high vacuum, 501
Welding machines, 421, 473
Winding machines, 503
Workholding devices, 472
Writing machine, automatic, 418

401-431—NEW EQUIPMENT—*page* 101 **432-466—NEW COMPONENTS—*page* 115**
467-511—CATALOGS & LITERATURE—*page* 141

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Page No. Title of Article

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404	434	464	494	524	554	584	614	644	674	704	734	764	794	824	854
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407	437	467	497	527	557	587	617	647	677	707	737	767	797	827	857
408	438	468	498	528	558	588	618	648	678	708	738	768	798	828	858
409	439	469	499	529	559	589	619	649	679	709	739	769	799	829	859
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412	442	472	502	532	562	592	622	652	682	712	742	772	802	832	862
413	443	473	503	533	563	593	623	653	683	713	743	773	803	833	863
414	444	474	504	534	564	594	624	654	684	714	744	774	804	834	864
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421	451	481	511	541	571	601	631	661	691	721	751	781	811	841	871
422	452	482	512	542	572	602	632	662	692	722	752	782	812	842	872
423	453	483	513	543	573	603	633	663	693	723	753	783	813	843	873
424	454	484	514	544	574	604	634	664	694	724	754	784	814	844	874
425	455	485	515	545	575	605	635	665	695	725	755	785	815	845	875
426	456	486	516	546	576	606	636	666	696	726	756	786	816	846	876
427	457	487	517	547	577	607	637	667	697	727	757	787	817	847	877
428	458	488	518	548	578	608	638	668	698	728	758	788	818	848	878
429	459	489	519	549	579	609	639	669	699	729	759	789	819	849	879
430	460	490	520	550	580	610	640	670	700	730	760	790	820	850	880

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416 446 476 506 536 566 596 626 656 686 716 746 776 806 836 866
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429 459 489 519 549 579 609 639 669 699 729 759 789 819 849 879
430 460 490 520 550 580 610 640 670 700 730 760 790 820 850 880

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2 in., 3-way 3-position, double solenoid type.

8 in., 2-way 2-position, double pilot cylinder type.

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If control of large volumes of air, oil, water, or soluble oil and water at pressures up to 5000 psi hyd. is one of your requirements, it'll pay you to talk to your Hunt representative. His specialized knowledge can save you hours and dollars. Call him today.

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QUICK-AS-WINK® AIR AND HYDRAULIC

VALVES

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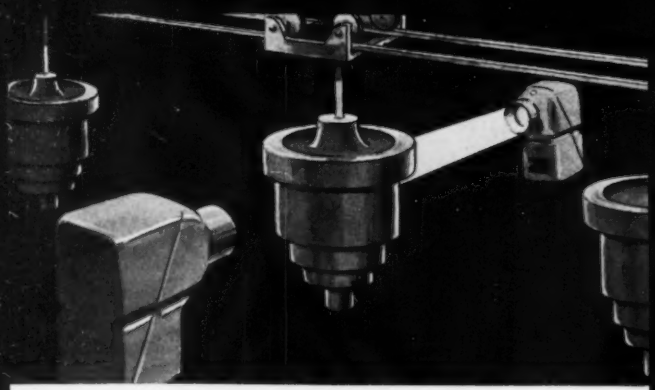
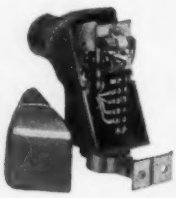
Circle 678 on Page 35

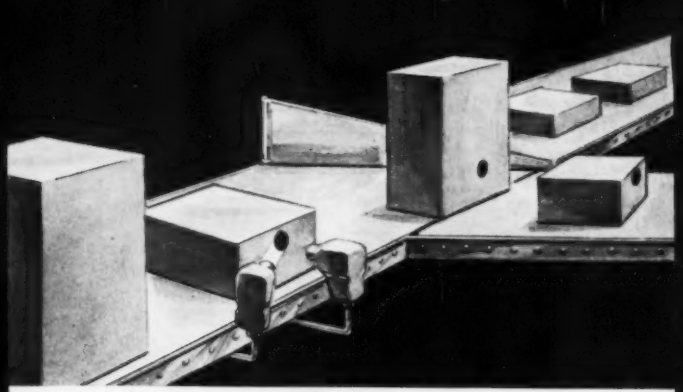


PRODUCTION COUNTING

Problem: Stepped-up production rate made it difficult to count units accurately with existing mechanical equipment.

Solution: Plant Electrician installed two low-cost G-E photoelectric units connected to automatic counter. Even though production units come in bursts of over 150 per minute, this simple counting setup now tallies them swiftly and accurately.

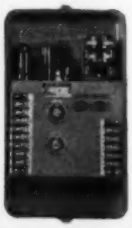


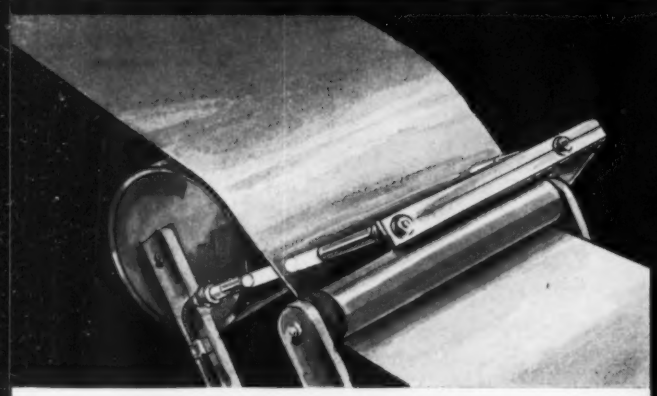


SORTING DISSIMILAR CARTONS

Problem: To automatically divert selected boxes from main conveyor to side conveyor.

Solution: Plant engineer suggested printing black circular marks on those boxes to be diverted. The absence of reflected light from the marked boxes trips the G-E photoelectric units and switches boxes to side conveyor. Unmarked boxes continue straight ahead on main conveyor.

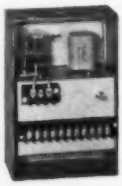


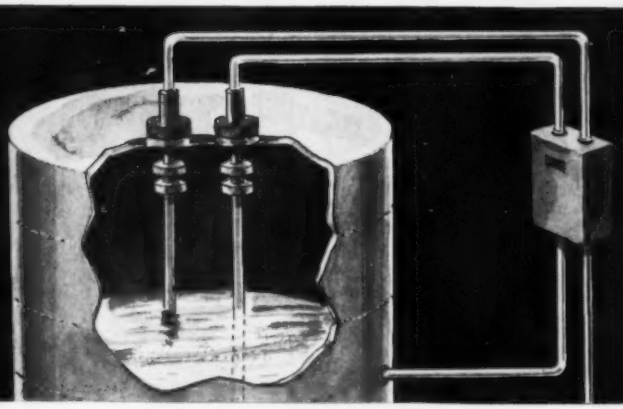


DETECTING WEB BREAKS

Problem: Paper mill experienced excess losses caused by web breaks and decided to investigate automatic detection equipment.

Solution: At G-E Application Engineer's suggestion, plant installed photoelectric web-break detectors. These units detect breaks instantly. Light penetrates through break to scanning photoelectric relay which immediately stops machine.

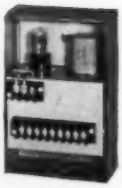




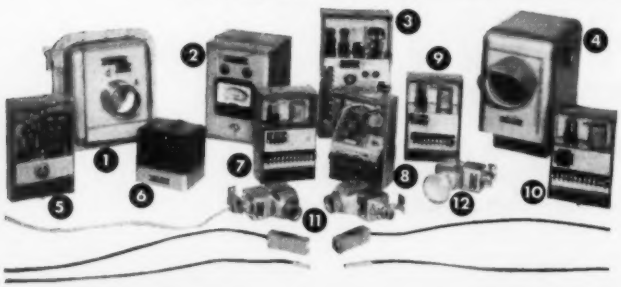
SENSING LIQUID LEVEL

Problem: Brewery planning to add 10 new vats wanted to equip them with most economical liquid level control.

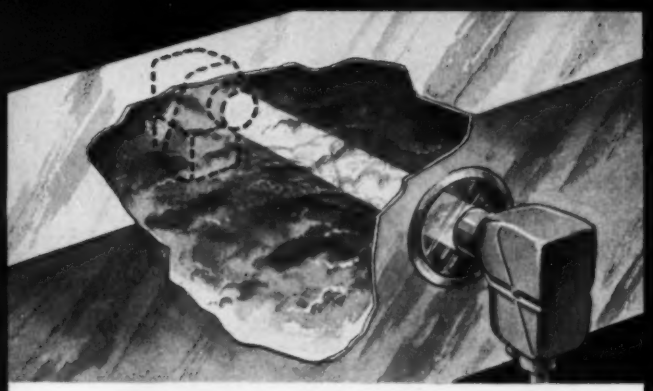
Solution: At the Plant Electrician's suggestion, General Electric resistance-sensitive relays with stainless steel probes were installed on each vat. These standard devices have only one moving part, are easy to install, and require little maintenance.



A complete line of photoelectric and electronic devices for controlling, sorting, limiting,



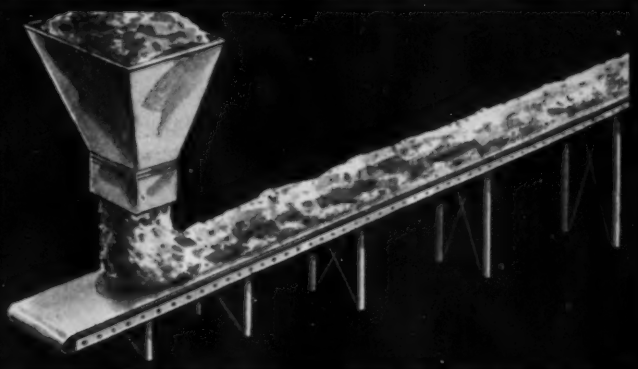
1. **Explosion-proof relay** is high-speed type in special enclosure for use in hazardous locations.
2. **Smoke density indicator** is designed for combustion control or alarm: range is adjustable from 3—100%.
3. **High-speed relay** offers .001-second sensitivity. It also includes time delay and interlock.
4. **Long-distance relay** will operate up to 2500 feet without adverse effects from ambient light.
5. **Voltage-sensitive relay** operates on input signal voltage that ranges above or below pre-selected value.
6. **General-purpose relay** is low-cost, indoor-type photoelectric relay, flexible to operate, easy to adjust.



MEASURING BURNING EFFICIENCY

Problem: To determine that furnace was operating economically, and well within local smoke ordinances.

Solution: Plant Engineer installed G-E electronic smoke density indicator. In addition to performing corrective action, the indicator coupled with a strip chart recorder gives a day-by-day record of burning efficiency. It also satisfies local authorities that smoke is within prescribed limits.



AUTOMATIC CONVEYOR UNLOADING

Problem: Plant wanted to prevent reversing of loaded conveyor upon shut-down of hopper.

Solution: Plant Electrician wired simple electronic timer to hopper switch and to conveyor motor. When hopper closes, timer starts, counts off 45 seconds (long enough for conveyor to dump load completely), then stops conveyor automatically.

CONTROLS FOR AUTOMATION

6 production problems SOLVED with General Electric electronic devices

These six production problems, and hundreds like them, are today readily solved with versatile General Electric electronic devices.

Applied with ingenuity, these devices now help plants sort, divert, detect, count, and perform other operations efficiently. And new uses turn up every day. For instance, the G-E resistance-sensitive relay is often used to control liquid level, but recently, it proved equally valuable as a thread-break detector!

Cash-in on such new uses of these versatile devices by contacting your authorized G-E Distributor early. He can solve many of your problems with electronic devices from stock. And his experience is invaluable on complex applications.

And for additional information on new ways to apply G-E electronic devices, return the coupon for your free copy of GEA-6822. General Electric Co. *Specialty Control Dept., Waynesboro, Va.*

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counting, and detecting applications

7. New high-speed relay is a low-cost unit for use with miniature or micro-miniature source and cell.
8. Transistorized relay features high reliability with miniature and micro-miniature source and cell.
9. Resistance sensitive relay operates on change in external resistance, ideal for liquid-level control.
10. Electronic timer is dial-set for given time; can be energized or de-energized before the timed interval.
11. Light sources and receivers are available in standard, miniature, and micro-miniature sizes.
12. Self-contained relay is low-cost, compact, tubeless photoelectric relay, ideal for limit-switch-type applications.

Circle 679 on Page 35

FREE CATALOG

General Electric Co., Section B793-05
Schenectady 5, New York

Please send me a copy of the G-E Electronic Devices catalog, GEA-6822, with description, specifications, and pricing data on the complete line.

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Company _____

Address _____

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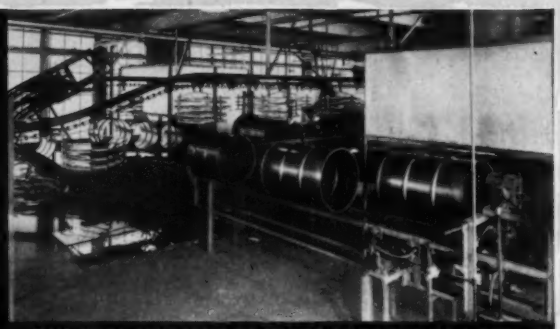
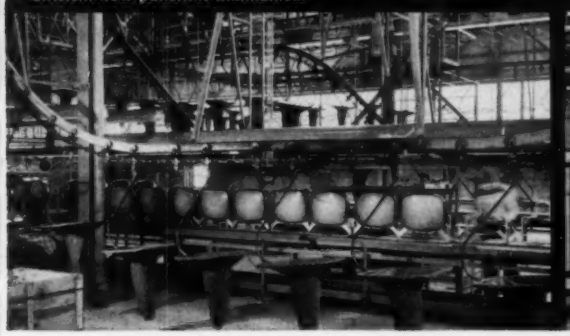
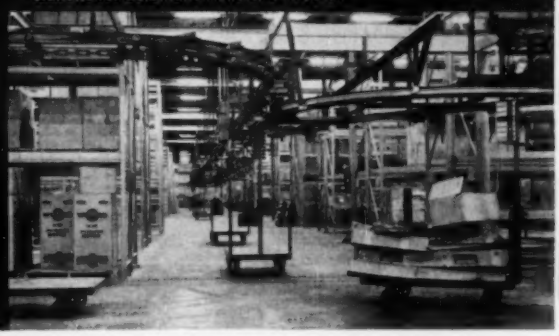
Package handling system for large auto parts distribution center. Photoelectric cells control automatic dispatch system.



Steel drums and covers are automatically moved into spray booths. Covers are brought from floor below.



A television tube conveyor on a chassis assembly line. Fast efficient flow pattern is maintained.



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CSI-*Farquhar's* complete approach to system handling problems can help you regain those lost profits

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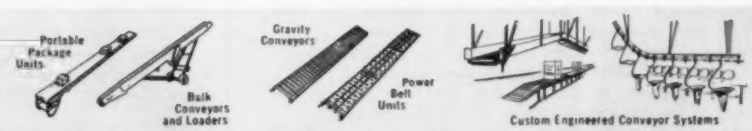
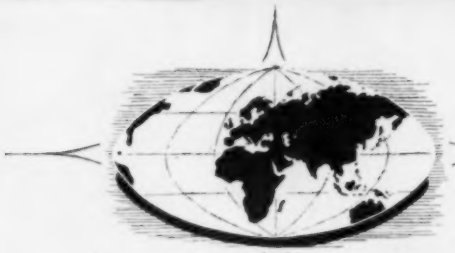
CSI Farquhar CONVEYORS

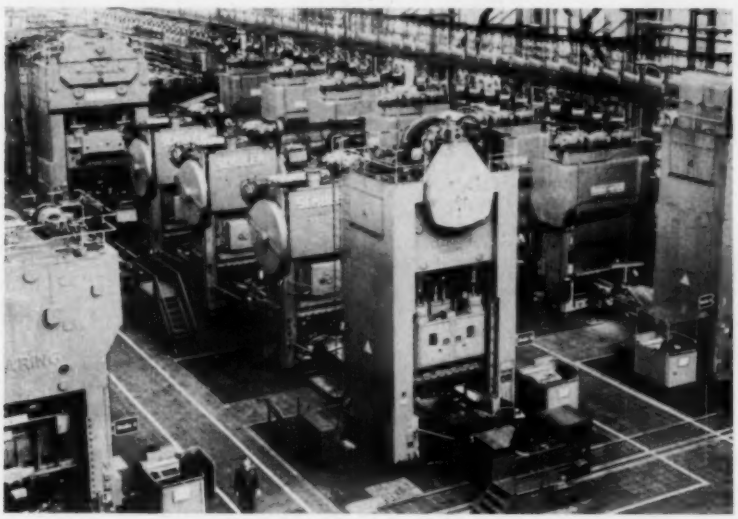


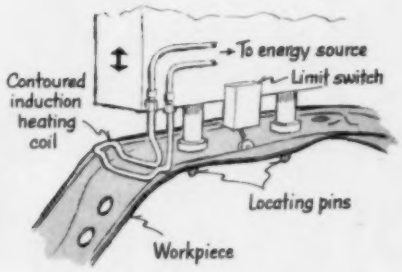
THE COMPLETE LINE OF CUSTOM AND PRE-ENGINEERED CONVEYING SYSTEMS

Circle 680 on Page 35



Lines of integrated presses are used to stamp body parts for VW passenger cars at Wolfsburg plant. Sketch illustrates induction heating station in transfer line between presses. Function of device is to relieve stresses induced in critical part sections by previous forming operations.





Volkswagen Visited

By **WILLIAM E. STALHUTH**
Associate Editor

VIRTUALLY worldwide acceptance of the small, beetle-shaped Volkswagen has been variously attributed to: Good basic design for a vehicle of its type, low first cost, freedom from nonengineering-type changes such as those inspired by "fashion" or "planned obsolescence," reliable performance, and economy of operation.

Whatever the appeal is to buyers, demands for the products have continually forced upon Volkswagen A.G. the necessity to upgrade and expand its production facilities. The result is that, today, the firm is said to be West Germany's largest company and the world's fourth largest automaker. In 1961, for example, more than 1 million standard vehicles will be produced. This figure does not include production of the new, larger VW-1500 passenger car that will make its official debut at the International Automobile Show in Frankfurt this September.

Aware of the size and success of VW operations, this editor eagerly accepted a recent invitation from Volkswagen of America Inc. to visit the overseas company and see firsthand the manufacturing methods employed. In 8 days, several VW plants and a good portion of the surrounding countryside were surveyed.

Some of the general features of Volkswagen operations, and specific examples of automatic manufacturing equipment in two major VW plants, are shown in the accompanying illustrations.

Modern Facilities

At the Wolfsburg plant, which is only five miles from the East German border, 37,000 employees in two 8-hour shifts assemble 3400 Volkswagens daily. About 60 per cent of the buildings that provide a total floor area of 20 million square feet at this location have been built since 1953. Factory buildings are of two-story construction so that all incoming materials can be received, checked, and stored at ground level. When needed, materials are moved from storage on the ground floor to second-floor production areas.

Other company plants include one at Hanover with 14,000 em-

(*Continued on page* 44)

Willi Schick, left, assistant to Chief of Planning at Volkswagen A.G., discusses plant operations with AUTOMATION's Bill Stalhuth.

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New Cutler-Hammer operator options provide top flexibility... world's best oiltight limit switch

For any use, anywhere, in any position . . . you just can't buy a more reliable, longer-life switch. No other switch is sealed more effectively . . . effectiveness we've proved under test conditions so rugged they will never be equaled in actual service. Even the silver-to-silver contacts are visible for quick inspection. For full details on this complete new line, write for Pub. ED-145-L283.

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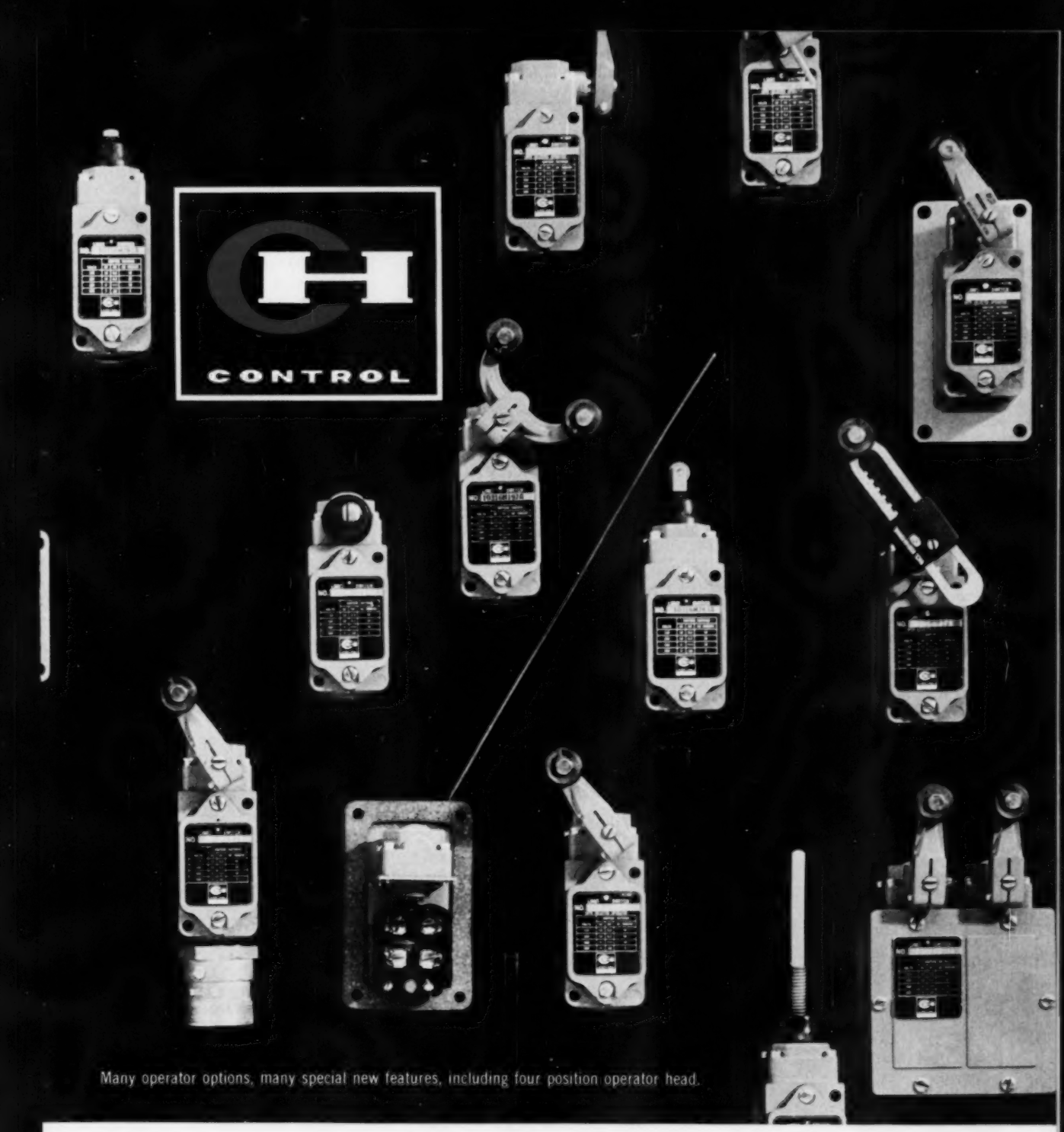

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Circle 681 on Page 35

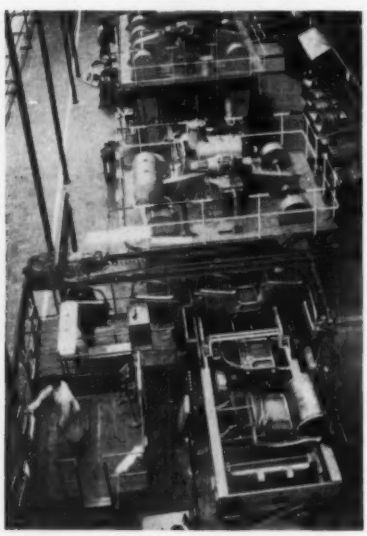
ployees where trucks, buses, and engines for all vehicles are produced; a plant in Kassel where spare parts are produced by 10,000 employees; and a front suspension assembly plant in Braunschweig that has 5000 workers.

Just Like Home

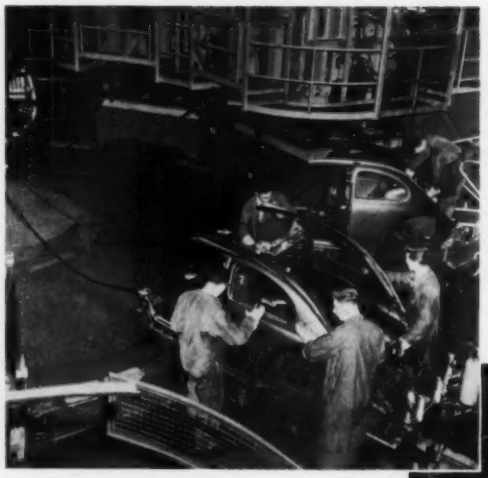
It can be stated from personal observation that production methods and management techniques employed at VW plants in Germany are thoroughly up to par. If they resemble American automotive industry practices, there is small reason to wonder. Heinz Nordhoff, president of the firm, in 1940 was head of the American-owned Opel lorry factory in Brandenburg. At that time, the factory was the largest and most modern of its type in Europe, with a production capacity of 4000 vehicles per month.

When he accepted from the British Occupation Forces the position of director general of the VW works, Nordhoff brought with him a wealth of automaking experience including knowledge of U. S. practices acquired at Opel. This was in 1948, and Nordhoff's inheritance was a bombed-out plant originally erected to produce "Strength-through-Joy" cars for Hitler.

If ever there was a "bootstrap" operation, Volkswagen's activities from that time are an example. Under Nordhoff's guidance, all efforts at Wolfsburg were directed to production. Annual output rose from 19,000 vehicles in 1948 to 90,000 two years later. A new line of commercial vehicles—not contemplated by Ferdinand Porsche who designed the original sedan—was added. Money for these operations was obtained not from Marshall Aid, but from dealer advances obtained when cars were exported to hard-currency nations such as Switzerland, Belgium, and Holland. In 1955, factories sprang up in Hanover and Kassel and 330,000 vehicles were built.



Doors are assembled and welded in automatic production line. When completed, they are transferred automatically to conveyor and inspected. 1/7 of VW workers are inspectors.



Rear bodies are assembled and welded in multistation roundabout. Parts are loaded in fixtures during machine dwell periods. Welding is done automatically when carriages containing fixtures and parts are lifted hydraulically into position.

Many U. S. Machines

Another American influence is seen in the relatively large percentage of U. S. machine tools and equipment in actual use in VW plants. At the assembly plant in Wolfsburg, for example, 48 large presses (Clearing and Danly) are used to stamp out body parts. McKay sheet levelers are also used. In the plating area, lines for buffing and polishing hub caps, bumpers, and bumper overriders were supplied by Acme Mfg. Co.

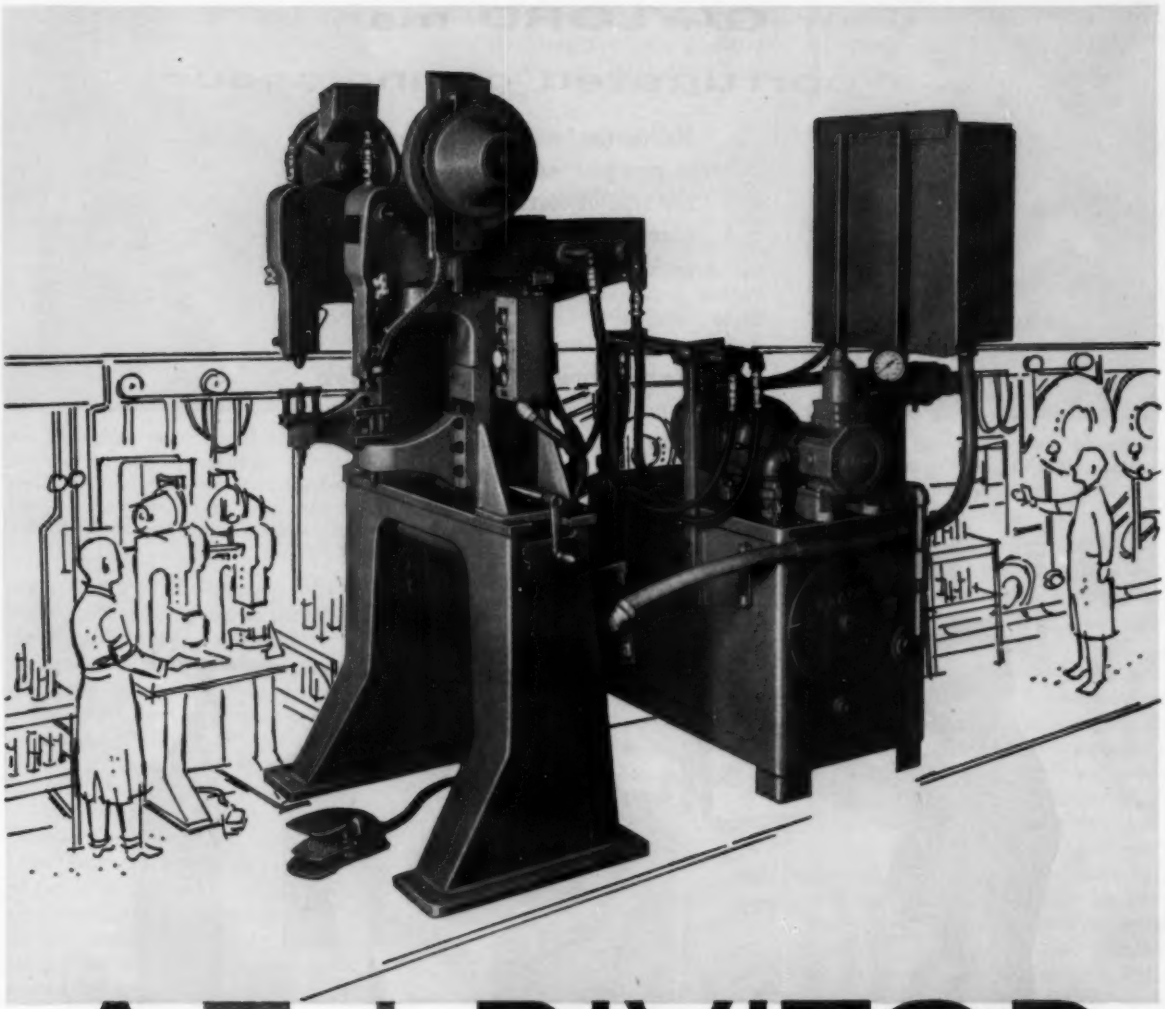
Statistics for the Hanover plant are equally impressive. Of 4000 new machines acquired to manufacture engines for the VW-1500, 500 are from this country. It would be impossible to mention all U. S. firms involved in the project, but a partial Who's Who includes: Bullard Co., Cleveland Hobbing & Machine Co., Detroit Broach & Machine Co., Ex-Cell-O Corp., Gisholt Machine Co., LeBlond Machine Tool Co., Lees Bradner Co., Norton Co., and Clark Equipment Co.

When asked why so many U. S. machines are being used, Mr. Nordhoff told me: "There are several reasons for this. In some cases your machines do jobs that no others can. In other instances, lead times prevail. But it must be remembered that our operations are international in scope. Even if a U. S. machine cost the same as a German one, and had the same performance and availability, its shipping cost would be higher. However, the U. S. is our best foreign customer (191,000 cars in 1960) and we're exchange minded." VW also buys about $700,000 worth of American steel and magnesium monthly in addition to coal and other items.

Special machinery in use at Wolfsburg includes door and roof assembly and welding lines, front and rear body assembly and welding turnabouts, and a gas tank assembly machine. Galvanic chrome plating equipment installed in the plant is fully automatic.

In the paint shop, automobile bodies are washed, phosphated, and immersed completely in paint primer. Second and third prime coats are applied with special Ransburg electrostatic paint spray equipment. With the arrangement, a spray head, suspended from the ceiling on a ram, is directed by cams and linkages so as to automatically tilt and move up and down to follow

(*Continued on page 47*)



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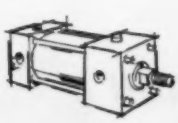
on your production line means higher production rate . . . lower unit cost!

T-J Rivitors and Clinchors are designed, engineered and manufactured to conform and operate efficiently on today's high-speed production lines. For whatever your product . . . if it demands a fastening assembly procedure . . . a T-J riveting or clinching machine adds to its high quality standards by their ability in providing long, rugged service-free life.

Many standard designs to choose from . . . or a T-J can be custom designed for your exact requirements. Write Tomkins-Johnson, 2425 W. Michigan Ave., Jackson, Mich., today. Ask for Rivitor and Clinchor Bulletin No. 646 or Clinchor Bulletin No. 555.

RIVITORS

CLINCHORS



CYLINDERS

CUTTING TOOLS

T-J TOMKINS-JOHNSON
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Circle 682 on Page 35

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He probably can suggest several ready-made answers to the container question foremost in your mind right now. After you make your choice, Gaylord tailors your box from a practically unlimited range of board.

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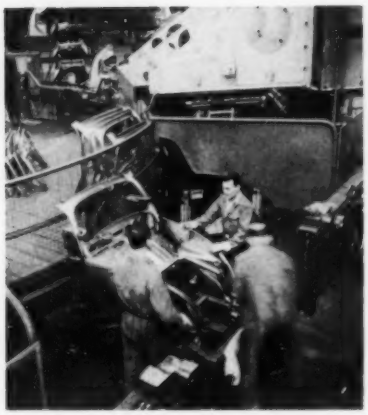
PLANTS COAST TO COAST

Circle 683 on Page 35



An 11-station roundabout containing one discharge, six loading, and four welding positions is provided for front body assemblies. Unit was built to VW specifications by a German firm.

the contour of the top surfaces of car bodies moving on a conveyor. Fixed spray heads coat the sides of the bodies. Finish coats are applied manually in any of seven, parallel paint spray lines that are normally set up for 10-day runs of one color.

Purchasing Policy

How does Volkswagen buy production equipment? According to Otto Hoehne, production manager of the Wolfsburg plant, most special equipment is built outside to VW design and engineering specifications. Electrical controls may be designed by specialty firms. As to the engineering costs charged by vendors, Mr. Hoehne said that VW assumes these are honestly arrived at by the seller unless prior experience indicates that such costs are grossly out of line.

All machine tools, including those from the U. S., come equipped with tooling. Where perishable tools are involved, 3 to 5 sets are ordered initially. Subsequent tools may be re-ordered from the source, built in-plant, or obtained elsewhere.

Volkswagen expects that equipment supplied by vendors will work when it is installed in the plant. Method of payment varies with the source: Where VW has had prior good experience with a builder, entire payment in the form of a Letter of Credit may accompany the order. In other cases, VW will pay ⅓ down, ⅓ when the equipment is ready for shipment, and the remaining ⅓ four weeks after delivery. If trouble is experienced, VW may notify the vendor that 5 per cent of the purchase price is being withheld pending final tryout of the equipment.

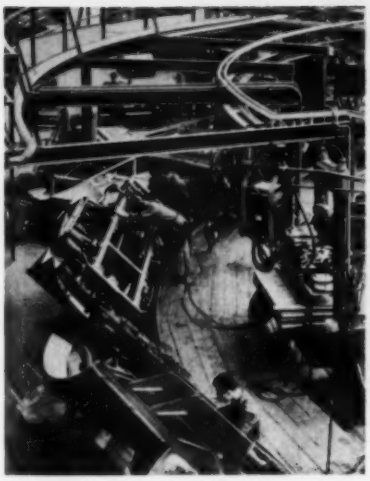
Cost Reduction

Volkswagen is keenly aware of the need to reduce manufacturing costs wherever possible. At Wolfsburg, responsibility for cost reduction programs is placed upon the Planning Dept. Usually, a project must show a payoff potential of 18 months before it will be adopted. Other activities of the Planning Dept. include manufacturing research on machinability and other means of increasing productivity. Altogether, 600 engineers are assigned to planning, tool design, and tool construction with another 200 engineers responsible for chassis production.

Another source for cost reduction ideas is through the company's Employee Suggestion System. All workers are invited to submit ideas contributing to quality, safety, or productivity. A typical award for an accepted suggestion that increases production is an amount equalling the first 3 months' savings.

Hanover Works

The truck, bus, and engine manufacturing plant in Hanover employs modern, automated machines and efficient handling equipment. Several large transfer machines are used to finish rough, magnesium alloy engine castings shipped from Wolfsburg. In one instance, a transfer machine combines American and German building-block units. An Ex-Cell-O fine boring machine is used with a Gehring honing machine. Gehring also supplied the transfer system that moves the workpieces through the multistep process.

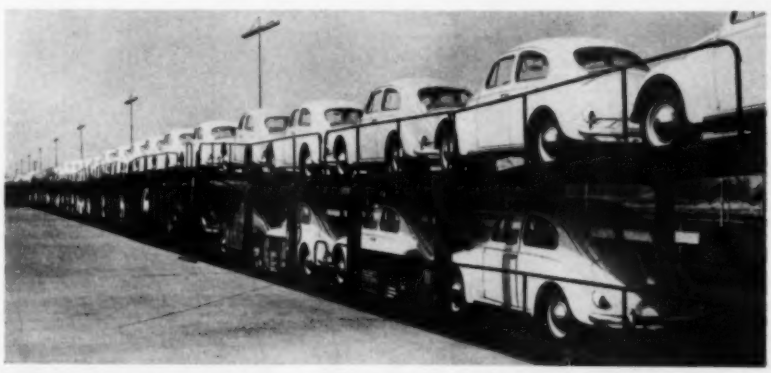


Frames for transporters are assembled and welded in tiltable fixtures carried on oval tracks at Hanover plant.

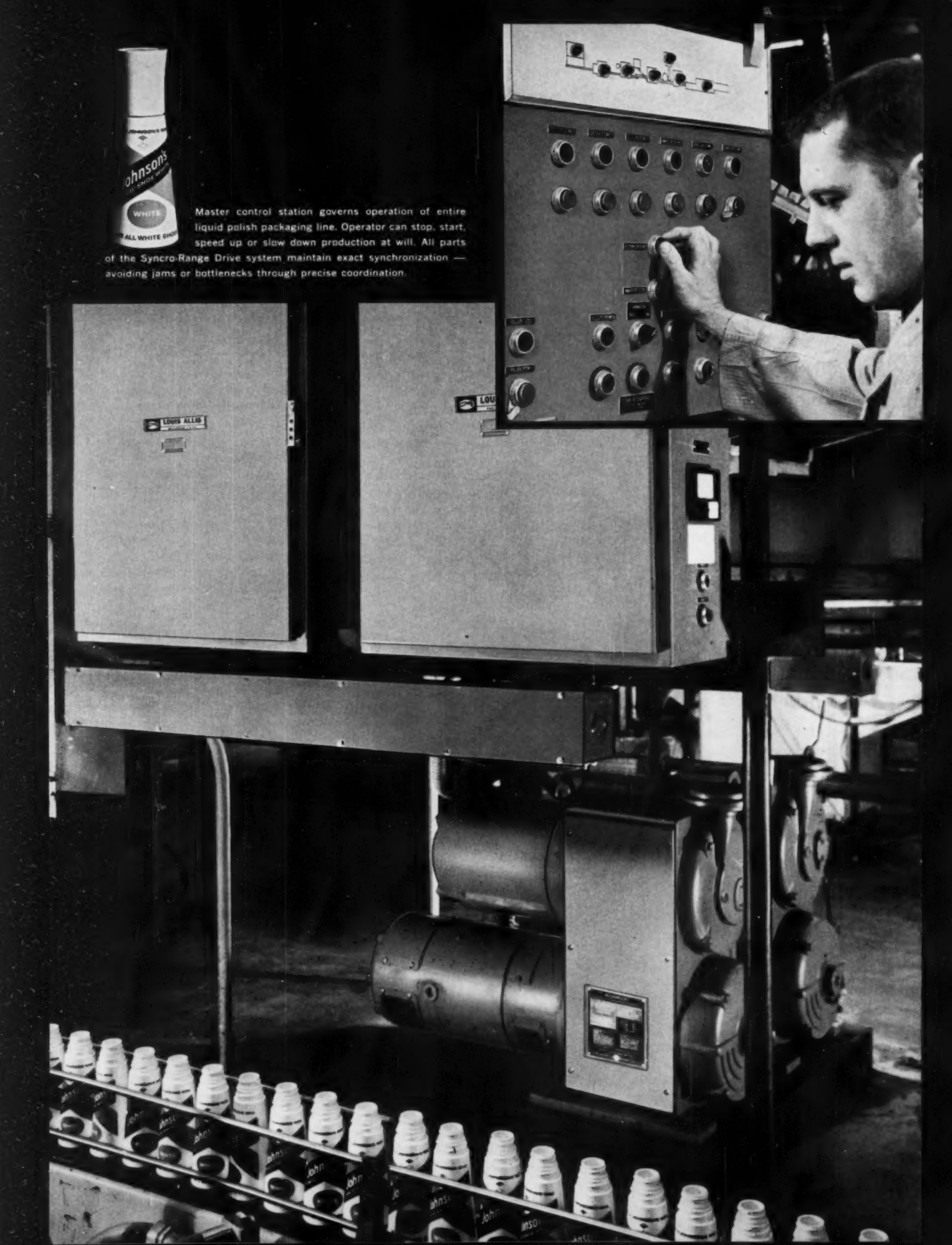
Design of transfer machines generally resembles U. S. automotive practice except that smaller, lightweight magnesium alloy components are handled and machining feeds and speeds are correspondingly high. Central consoles from which operations may be monitored and controlled are common, as are tool boards where cutters may be preset and stored in spindles until needed. Counters on the consoles register workhead cycles and indicate when tools should be changed.

According to Joachim Hoppe, a manufacturing engineer at the Hanover Works, records are kept of the frequencies, durations, and causes of downtimes for transfer and all other

(*Continued on Page* 50)

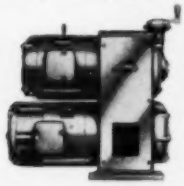


Finished passenger cars are driven onto special double-deck freight cars that hold five automobiles on each deck. A train of 25 freight cars can be loaded in one hour. 95 per cent of products are shipped in this manner.

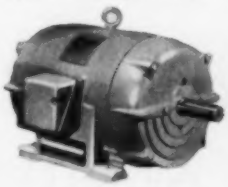


Master control station governs operation of entire liquid polish packaging line. Operator can stop, start, speed up or slow down production at will. All parts of the Syncro-Range Drive system maintain exact synchronization — avoiding jams or bottlenecks through precise coordination.

The key components of the Syncro-Range Drive...



Adjustable Frequency Power Supply . . .



. . . and Standard or Syncro-Spede Motors!

LOUIS ALLIS SYNCRO-RANGE DRIVES automate liquid polish lines

Johnson's Wax, renowned wax and polish producer, uses Syncro-Range Drives for exact control of process lines

Controlling speed of the precise, mass-production lines for their new, highly successful liquid shoe polish was the task Louis Allis engineers had to solve for Johnson's Wax.

The problem was to time the flow of plastic bottles, liquid polish, wool daubers, and caps into the packaging lines at precisely equal rates. Flow rate must be adjustable so the lines can be slowed down or speeded up. And the entire packaging operation must be controllable from a single master control. The Louis Allis Syncro-Range Drive solved the problem.

Syncro-Range Drives provide synchronized speed of any number of motors from a single control. It is a "packaged system" comprising an adjustable-frequency power supply operating on 3 phase, 60 cycle power input . . . a group of Syncro-Spede® synchronous motors which maintain exact synchronism regardless of varying load . . . and a control which permits the speed of the entire group of motors to be simply adjusted without losing synchronization. On applications for which exact synchronism is not required, standard squirrel-cage motors can be supplied.

You can readily see the advantages of the Syncro-Range Drive in systems or processes which require synchronized movement: multiple conveyors which feed consecutively; transfer lines; process lines; assembly lines requiring coordinated arrival of components; printing where one press feeds another; synthetic fibre spinning, drawing, or twisting; metal runout tables; and many other similar continuous-process machines which require the application of power at a number of points on the machine.

The Syncro-Range Drive is available with a choice of drive sizes to efficiently control from 2 to 200 (or more!) standard or Syncro-Spede motors of the same or different horsepower ratings. The Syncro-Spede motor is an A-C synchronous induction motor without slip rings or D-C excitation. It requires no more upkeep than a standard, squirrel-cage motor and can be supplied in open drip-proof, enclosed, or explosion-proof enclosures with mechanical modifications to match your requirements.

A sophisticated selection of control features are available in the system, including motor starters, main line circuit breaker or fusible disconnect switch, speed adjustment, speed indicator, remote control, and automatic control governed by temperature, pressure, or flow sensing devices. Controls can provide speed regulation accurate to 0.1% with 0% relative speed difference between motors!

Investigate the application of the Syncro-Range Drive system to *your* process. A trained Louis Allis motor application engineer is always available. You can reach him at your local Louis Allis District Office, or by writing direct to The Louis Allis Company, 463 East Stewart Street, Milwaukee 1, Wisconsin.

MANUFACTURER OF ELECTRIC MOTORS AND ADJUSTABLE SPEED DRIVES

LOUIS ALLIS

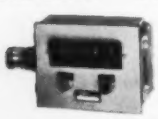
A80-231

Circle 684 on Page 35

True, 99%
of you don't know
Dynapar from Dinosaur
...but those that do
are getting more profitable results
with our digital control and
instrumentation!

Dynapar is the electronic subsidiary of The Louis Allis Co. We make a full line of transistorized digital devices for high-speed counting, measuring, and control.

Information on any of these products can be obtained from your local Louis Allis District Office — which is listed in The Yellow Pages under "Electric Motors."


Draw Indicators

Process Controllers

Rotopulsers

00-228

DYNAPAR CORP., 463 E. STEWART ST., MILWAUKEE 1, WIS. *A subsidiary of The Louis Allis Co.*

Transporters move on elevated tracks for final assembly. Production rate is 600 vehicles of this type per day.

types of production machines in the plant. Historical data of this type were said to be of inestimable value in planning and specifying new equipment for VW-1500 engines.

Special production equipment has been developed for engine assembly, including a 3-station assembly machine that shrink-fits valve bushings in cylinder heads. The bushings are fed in tracks from overhead vibratory feeders and are shrunk in a cold well before being pressed automatically into the heads.

Overhead conveyors move parts between operations and finished engines to storage. After they have been performance-tested on rotary test stands, engines are hung on carriers on conveyors. An inspector noting some fault in an engine can set a flipper on the carrier and the engine will be automatically routed to the proper area for repair.

Quo Vadis?

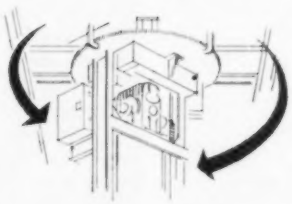
Only the future will tell what success the company will have with its new VW-1500 model. But one thing is certain. If the same planning, energy, and technical competence have gone into its development as have made Volkswagen a major contender for the automobile market in the past, even greater success for the company may be expected from this move.

A lot is riding on this car. Particularly in Wolfsburg, a one-product town, thousands of workers and their families depend for their livelihoods on a vigorous, growing market for Volkswagens.

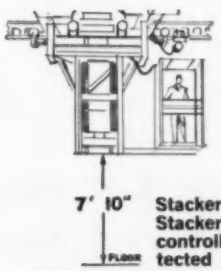
STACKER CRANE *HIGHLY PROFITABLE* IN WAREHOUSE

- *Speeds Order Make-Up*
- *Promotes Orderliness*
- *Cuts Handling Costs*

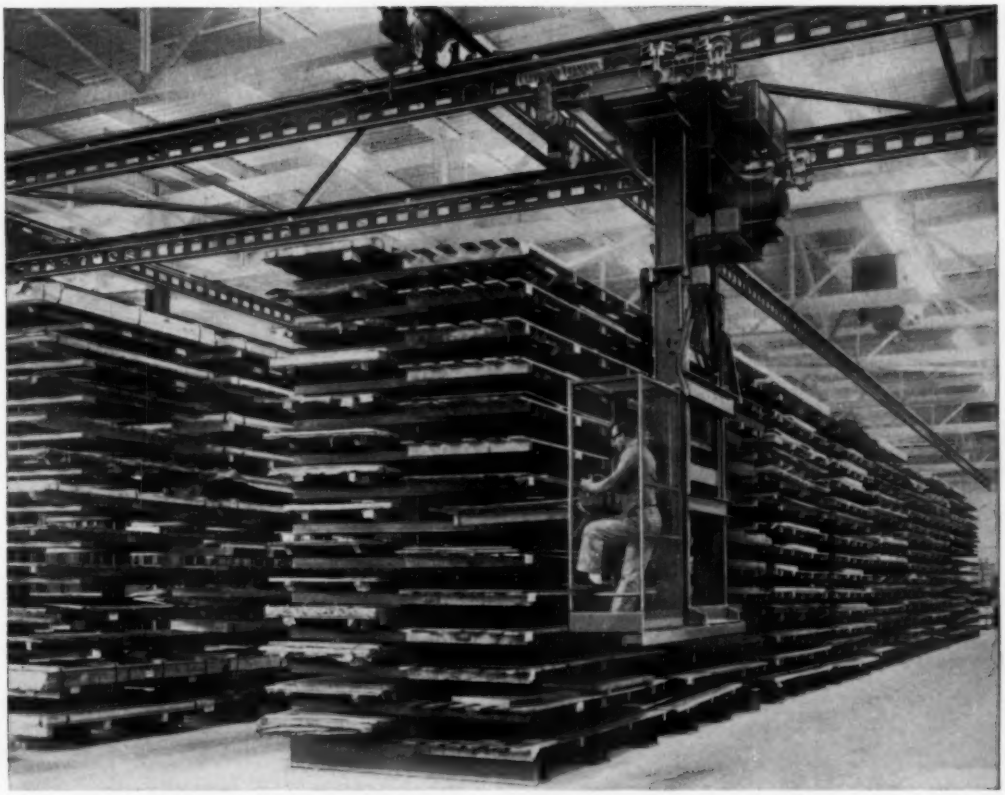
Heavy and unwieldy materials are quickly handled to and away from storage racks with this stacker crane. The stacker may be traveled from end to end of the 60-foot crane which in turn operates for the length of the building.



Stacker rotates clockwise or counterclockwise.



Stacker fork in high position. Stacker and crane motions are controlled from cab. Cab is protected with heavy mesh screen.



A Cleveland Tramrail Stacker Crane in the new modern Cleveland warehouse of Copper & Brass Sales, Inc. is a major factor in cutting costs and enabling fast service to their customers.

One man riding in the stacker cab handles up to three-ton packages of copper, brass, aluminum, etc., to and from the storage racks in fast time. The stacker fork has a lift of 15'-7" and can be lowered to the floor or rotated clockwise or counterclockwise without restriction. Because the mast telescopes, it will clear over machinery or other items on the floor. Maximum clearance is 7'-10".

Aisleway space required for operation of the stacker is remarkably small, usually for flat plate this is only a few inches more than double the plate width. For instance, 4'-0" wide material requires an aisle width of 8'-10", allowing 13" clearance on both sides. For 3'-0" material, the aisle width may be reduced to 6'-8", allowing 12" on both sides.

Cleveland Tramrail Stacker cranes make possible many advantages for warehouses and other applications. They are available in various designs and can be tailored to exactly suit the requirements. We welcome an opportunity for our nearby sales engineer to discuss your problem with you.

CLEVELAND TRAMRAIL

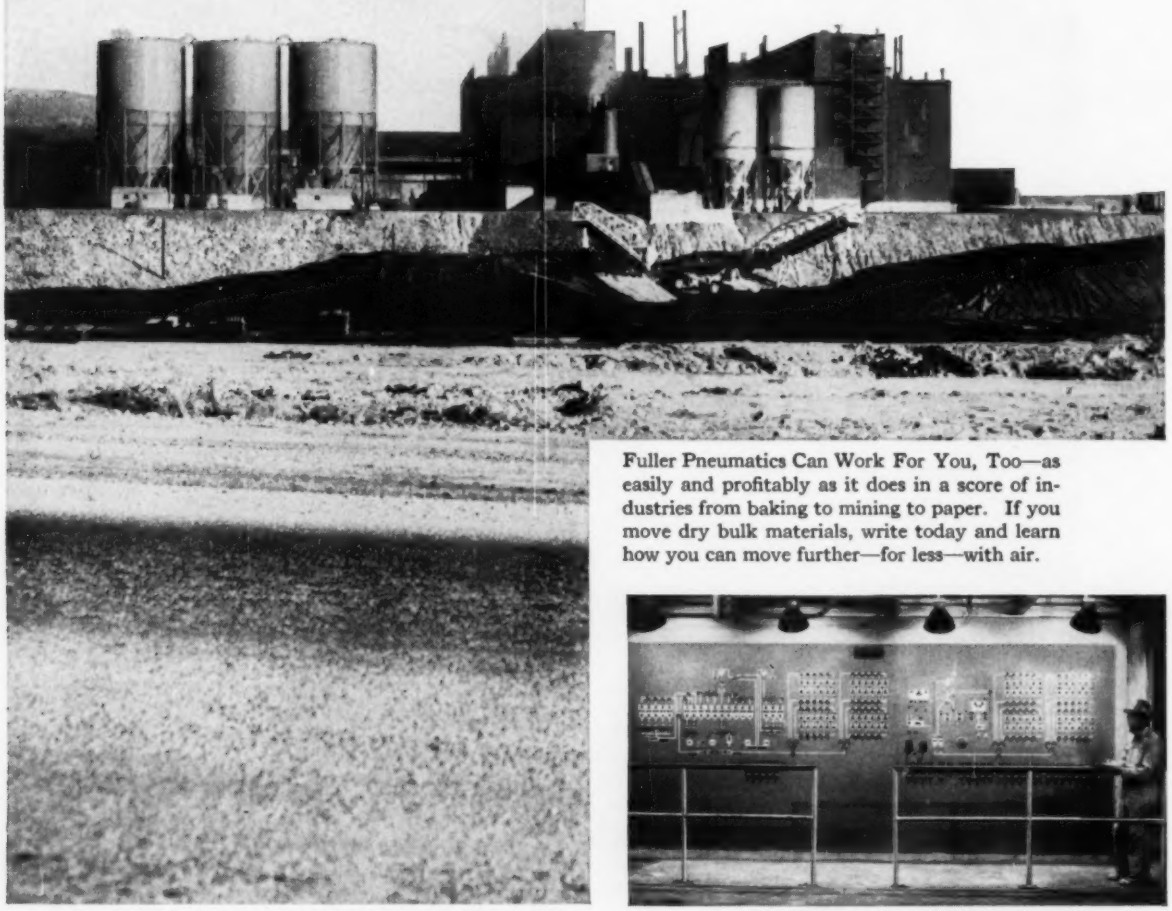
Overhead Materials Handling Equipment

CLEVELAND TRAMRAIL DIVISION • THE CLEVELAND CRANE & ENGINEERING CO. • 1356 E. 290 ST. • WICKLIFFE, OHIO

How Pneumatic Conveying Helps Make New Mining Process Economically Practical

They're turning low assay iron ore into rich pellets on the Mesabi these days. Moving additives for pelletizing, Fuller plays a special role in this feat of engineering and production economy.

Fuller Pneumatic Conveying Systems are carrying fine anthracite screenings, soda ash, and bentonite from siding to storage to processing—with speed, safety, sanitation, and efficiency. With few moving parts to wear out and powered by inexpensive low-pressure air, Fuller Pneumatic Conveying Systems speed dry bulk materials *anywhere that a pipeline can be run:* under ground, up through floors, around corners . . . for far greater distances and at substantially lower cost than possible with mechanical conveyors.



Four Fuller Pneumatic Systems can speed more than 307 long *tons* of additives through this huge Taconite Pelletizing Plant in a single day.

Fuller Pneumatics Can Work For You, Too—as easily and profitably as it does in a score of industries from baking to mining to paper. If you move dry bulk materials, write today and learn how you can move further—for less—with air.

Centralized control is provided by giant panel designed and manufactured by Fuller.

FULLER COMPANY GENERAL AMERICAN TRADE MARK

FULLER COMPANY
162 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Offices in Principal Cities Throughout the World

Fuller
....pioneers in harnessing AIR

2097
G229

Circle 687 on Page 35

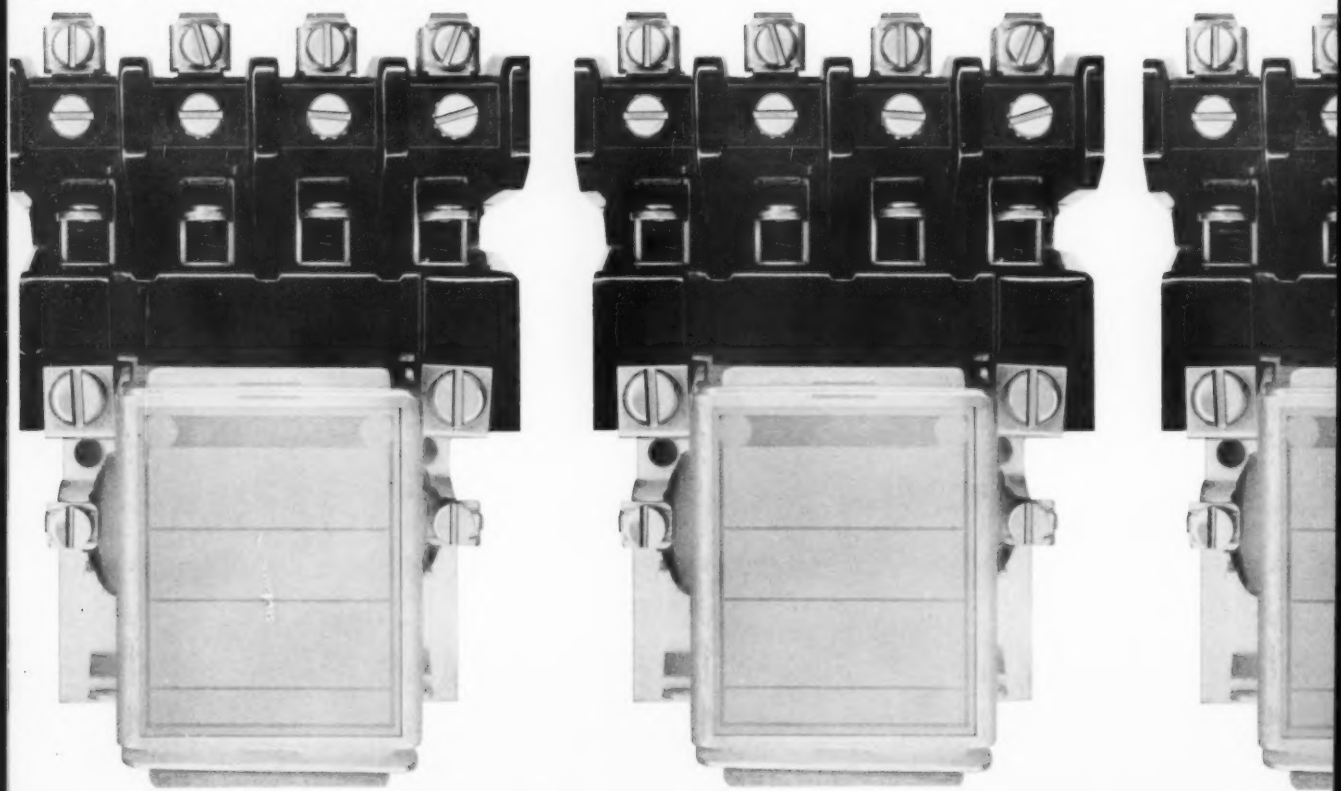
Circle 688 on Page 35→

Westinghouse® Westinghouse® Westinghouse® Westinghouse®

New Westinghouse BF relay shrinks machine control relay panel space 33% to 78%

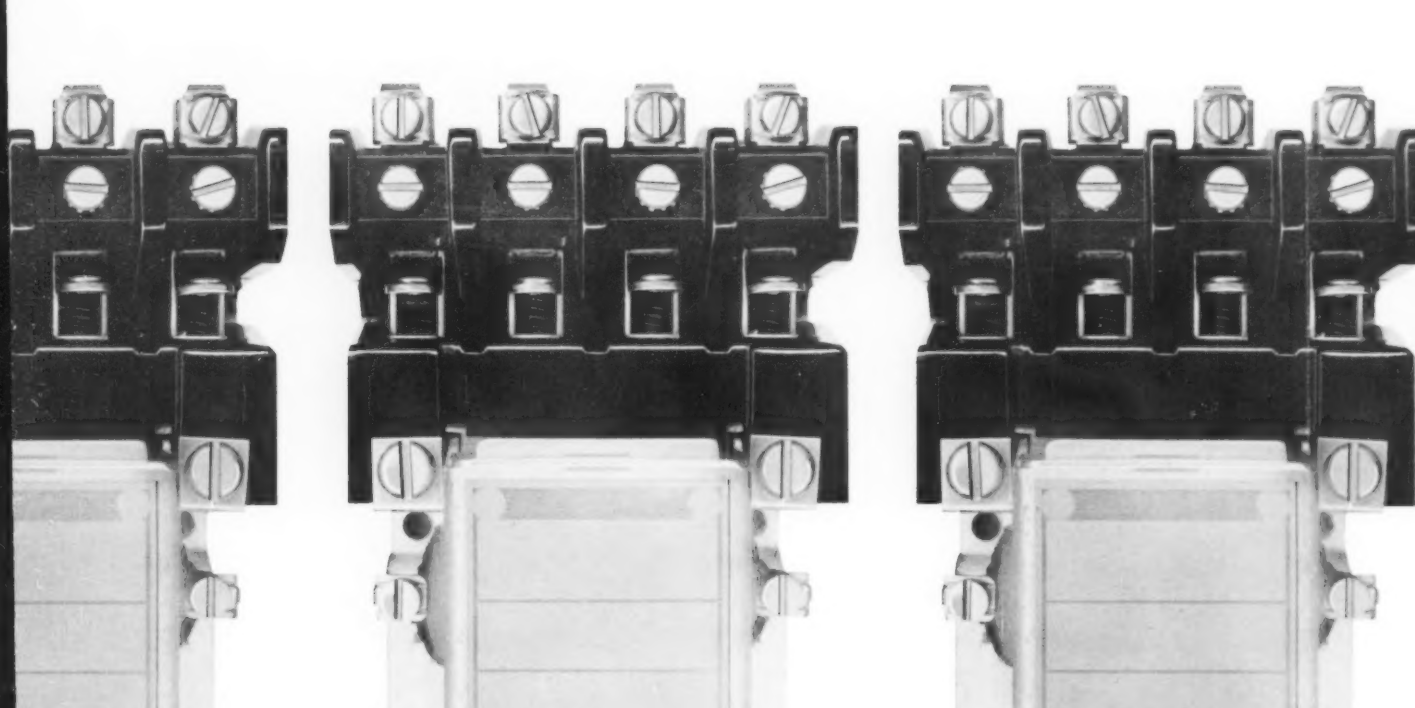
See for yourself how many new Westinghouse BF relays

ALL PHOTOS ACTUAL SIZE



Westinghouse
Westinghouse
Westinghouse
Westinghouse

can fit in the same space as 7 conventional relays—this is how



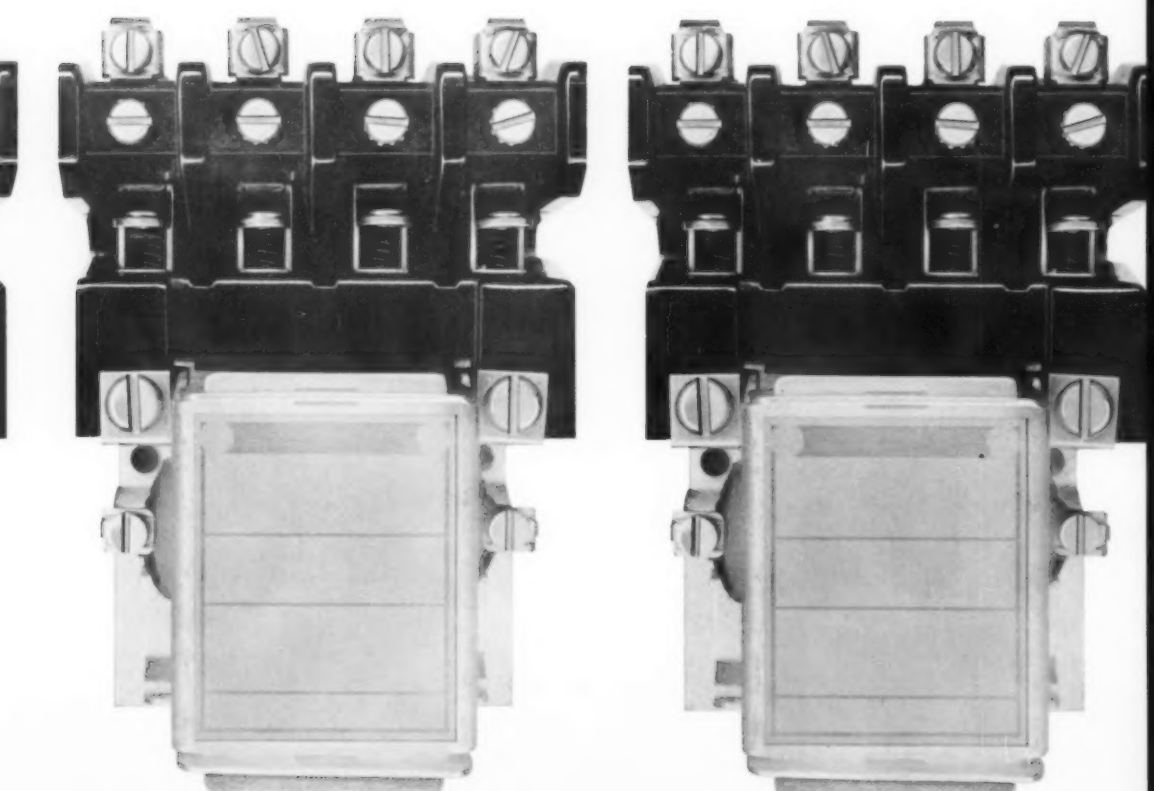
General characteristics
of the
Westinghouse BF relay

How the new
Westinghouse design
assures reliability
and durability

CONTA
ARRAN

w control panels can be reduced as much as 78%

You can be sure . . . if it's Westinghouse



BF relay contact information

CT GEMENT	8 POLE				
	8 N.O. 0 N.C.	7 N.O. 1 N.C.	6 N.O. 2 N.C.	5 N.O. 3 N.C.	4 N.O. 4 N.C.
REAR					

6 POLE				
6 N.O. 0 N.C.	5 N.O. 1 N.C.	4 N.O. 2 N.C.	3 N.O. 3 N.C.	2 N.O. 4 N.C.

General characteristics of the Westinghouse BF relay

Dimensions

Without base plate: $1\frac{11}{16}$" x $2\frac{3}{8}$"
With base plate: $1\frac{11}{16}$" x $3\frac{1}{8}$"

Operating time

Pickup: 12.5 to 18.0 milliseconds
Dropout: 6.25 to 12.5 milliseconds

Relay can be operated manually to test circuits.

4 and 8 pole frames in any combination or normally open and normally closed contacts with a maximum of 4 normally closed.

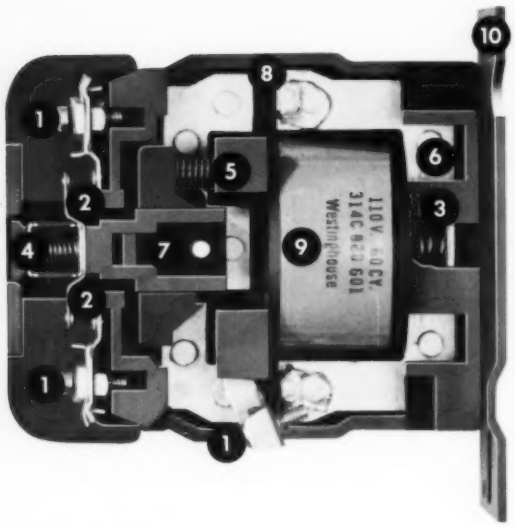
Contact rating—6 amps. 300 volts AC. 60 amperes inrush.

Relay can be mounted in any position on a vertical surface without changing operational characteristics.

The Westinghouse BF relay provides these features

- up to 78% less mounting space required
- front accessible
- can be butted without extra space for wiring
- quick coil and contact changes when needed
- low operating temperature
- lower installed cost
- long service life
- magnet and armature have specially hardened pole faces
- shorter operating stroke
- lightweight operating parts
- silver alloy contacts have built-in wiping action for prolonged circuit continuity

How the new Westinghouse design assures reliability and durability



EASILY WIRED

1. All connections are wired from the front with pressure clamp terminals.

OUTSTANDING CIRCUIT CONTINUITY

2. Proper contact wipe is built-in for long life of the silver alloy contacts and for positive circuit continuity.
3. Contact bounce is minimized by unique magnet suspension that eliminates shock and jar.
4. Automatic, positive alignment of crossarm insures simultaneous contact of all poles.

POSITIVE OPERATION

5. Stainless steel kickout springs permit any mounting position on a vertical surface — independent of gravity.

LONG MECHANICAL LIFE

6. In addition to preventing contact bounce, the magnet suspension cushions the contact between armature and magnet, protecting entire unit from shock.
7. Low mass and short stroke, possible only with a small relay, save wear on every moving part.
8. Pole faces are surface hardened to maintain desired air gap.

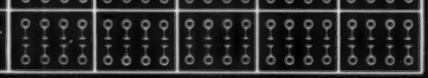
MINIMUM POWER LOSS

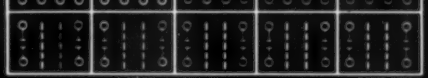
9. Closed gap coil loss is only 3 watts for low coil operating temperature. Open coil burden 70 volt amps; closed, 11 volt amps.

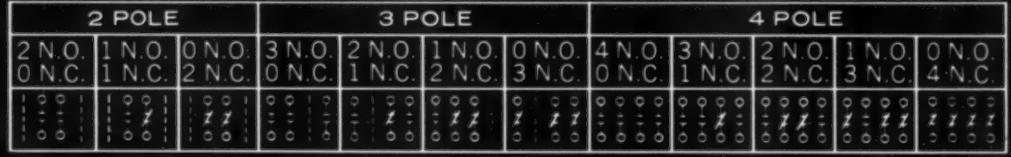
EASE OF MOUNTING

10. Steel base has keyhole slots for rapid installation, extends only into wiring area to avoid space waste, and may be removed if desired.

BF relay contact information

CT GEMENT	8 POLE				
	8 N.O. 0 N.C.	7 N.O. 1 N.C.	6 N.O. 2 N.C.	5 N.O. 3 N.C.	4 N.O. 4 N.C.
REAR					
FRONT					

6 POLE				
6 N.O. 0 N.C.	5 N.O. 1 N.C.	4 N.O. 2 N.C.	3 N.O. 3 N.C.	2 N.O. 4 N.C.
				

CT GEMENT	2 POLE			3 POLE				4 POLE				
	2 N.O. 0 N.C.	1 N.O. 1 N.C.	0 N.O. 2 N.C.	3 N.O. 0 N.C.	2 N.O. 1 N.C.	1 N.O. 2 N.C.	0 N.O. 3 N.C.	4 N.O. 0 N.C.	3 N.O. 1 N.C.	2 N.O. 2 N.C.	1 N.O. 3 N.C.	0 N.O. 4 N.C.
												

N.O.—Normally Open N.C.—Normally Closed

Westinghouse engineers have helped solve the design problem caused by the enlarged control panels needed to operate highly complex automated machine tools. The new Westinghouse BF Control Relay — although compact in size — has a rated full load current of 6 amperes at 300 volts AC. In new or modernized facilities it assures more productive capacity per square foot from every automated machine tool.

Type BF—60 cycles

number of poles	contacts		open type catalog number
	normally open	normally closed	
2	2	0	BF20A
	1	1	BF11A
	0	2	BF02A
3	3	0	BF30A
	2	1	BF21A
	1	2	BF12A
	0	3	BF03A
4	4	0	BF40A
	3	1	BF31A
	2	2	BF22A
	1	3	BF13A
	0	4	BF04A
6	6	0	BF60A
	5	1	BF51A
	4	2	BF42A
	3	3	BF33A
	2	4	BF24A
8	8	0	BF80A
	7	1	BF71A
	6	2	BF62A
	5	3	BF53A
	4	4	BF44A

Ordering information

BF Relays are available direct through your nearest Westinghouse representative. When ordering be sure to specify the total number of poles desired, including the number of poles open and the number closed. Also specify coil control voltage and cycles. The chart at the left shows some of the most widely used relays with 110-volt, 60-cycle control voltage. Consult your Westinghouse representative about other BF Relays which are available. Or write Westinghouse Standard Control Division, Beaver, Pa.

You can be sure . . . if it's Westinghouse

J1-30323 1

JUNE 1961

Justifiable Research

Much of the writing and thinking concerning economic justification of automation projects cautions the justifier to be sure that the product life is sufficient to warrant the expenditures required for the special equipment envisioned. This sensible warning may be responsible for a reluctance on the part of many job-lot manufacturers to spend any money on manufacturing research activities.

Because no one particular product line or manufacturing order is big enough to support a full-blown research and development program is no reason why such companies should not be probing for new production techniques. Categorically job-lot manufacturers must set up manufacturing processes for a seemingly never-ending parade of different products. This means they have a greater need for the know-how of establishing production systems than the "make-em-by-the-millions-boys." They do more of it.

Often the job-lot manufacturer earns his bread and butter by his ability to quickly supply a limited quantity of much needed parts. These may or may not be proprietary products, but the producers' success in the marketplace may depend more on manufacturing know-how than on product design ingenuity.

In order to nurture his big selling point, the manufacturer in this category is well advised to set aside a certain per cent of each sales dollar for manufacturing research on production techniques that complement his existing facilities and broaden his corporate know-how.

The fruits of automatic manufacturing operations are not reserved for companies with products made in high quantity. A degree of automation can be achieved for any manufacturing operation no matter how many parts are involved. However, all such progress is achieved by a series of small steps forward.

To assume that all steps of a particular project must be paid for by one product line or one customer's order is to place this type of progress in the wrong accounting category, and forfeit the competitive contest to those firms that recognize the research nature of the problem.

The company that budgets an amount for manufacturing research today is most likely to be in business tomorrow.

James C. Keebler

EDITOR

STEPPINGSTONES TO NUMERICAL CONTROL

By **NILS O. OLESTEN**, General Supervisor, Numerical Control Dept., Rohr Aircraft Corp., Chula Vista, Calif.

NUMERICAL CONTROL has been defined in many ways. But perhaps the most significant definition is that numerical control is a means for bringing the decision making in many manufacturing operations closer to management. From the mechanical standpoint, numerical control is nothing more than the guidance of machine tool operations—or other shop functions—by magnetic tape, punched paper tape, or punched cards, which transmit electrical control impulses on a number code.

In the case of numerically controlled machine tool operations, dimensions necessary to machine a part are taken from an engineering drawing and transformed by manual processes into part geometry. This part geometry is subjected to electronic processing by computers and transformed into control media necessary to guide the movements of the machine table and cutter head. The control media—card or tape—provides a fixed sequence of motions which the tool must follow to fabricate production or tooling parts.

In this discussion we will deal primarily with continuous path numerical control machine tool operation as applied to both two-dimensional and three-dimensional parts. While this is only one of several approaches to numerical control, and only a small part of our new philosophy of manufacturing, it is generally considered the most sophisticated and perhaps the most promising approach. There are, of course, applications where discrete positioning, or point-to-point, systems are perfectly adequate. Electronic tracer control can be the ideal solution where part configurations and economic considerations point that way.

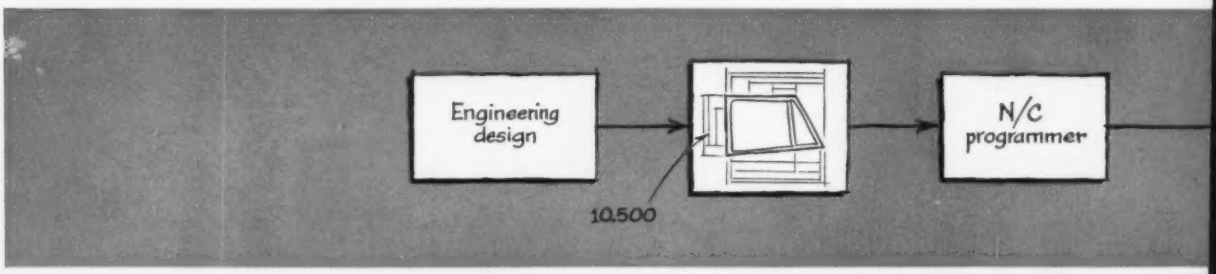
True numerical control operations, however, are a major step upward, from the fixed-program automation fairly common today, toward automation based upon fully selectable programming. Hundreds of numerical control systems already are in operation, and the transition is just beginning. These new systems are bringing an entirely new level of flexibility and automatic operation.

While some of the advantages of numerical control are well known today, there are others which are sometimes overlooked. Along with greater flexibility and near-perfect repeatability, numerical control reduces tooling and shortens lead time. It saves space formerly required for template, jig, and fixture storage and gives maximum control of the machine to management. Engineering management, for example, can arrive at a drawing either conventionally or mathematically, and the information will go to manufacturing precisely as it was established in engineering. This means that dimensions given on an engineering print will be used directly by the machine tool control system. The simplified flow diagram in *Fig.* 1 illustrates this point.

The Numerical Control Trend

Continuous path numerical control development in the aerospace industry started approximately a decade ago, with the realization that efforts had to be made to shorten lead times in the vital military flight programs. Changing aircraft configurations

This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.



Numerical control offers automatic manufacturing operations for job-lot manufacturers. Management must participate in the program by providing the necessary organizational and training climates for the growth of this technique. Managers who understand what they must contribute are more likely to get the results they expect.

were beginning to call for parts almost impossible to manufacture through conventional methods. The Air Materiel Command, Massachusetts Institute of Technology, and the Aerospace Industries Association joined forces in this effort. Machine tool builders, computer manufacturers, and electronics firms all have contributed research effort to come up with the various systems we have in operation today. This work is continuing on several fronts, as we work for more flexible and sophisticated programming systems and the machine tools needed to utilize these systems.

So far, continuous path numerical control has been used almost exclusively by the aerospace industries. Rohr was among the first firms to receive Air Materiel Command machine tools, and the company's position as a subcontractor to the entire aerospace industry forced us to an accelerated effort in the development of programming systems to make maximum use of these machines. There are now nine numerically controlled mills under Rohr's control. On these machines we produce a great variety of complex parts, both from aluminum alloys and hard steels, *Fig.* 2.

The larger primes in the aircraft industry have been the leaders in numerical control. They were first, of course, to receive the Air Materiel Command equipment and also to participate in the previously mentioned joint program for development of sophisticated computer routines to aid in part programming. While there is little specific information available, it is known that the automotive industry is looking to numerical control for tooling, models, and template making. It appears that template cutting will be a typical numerical control application within the automotive industry.

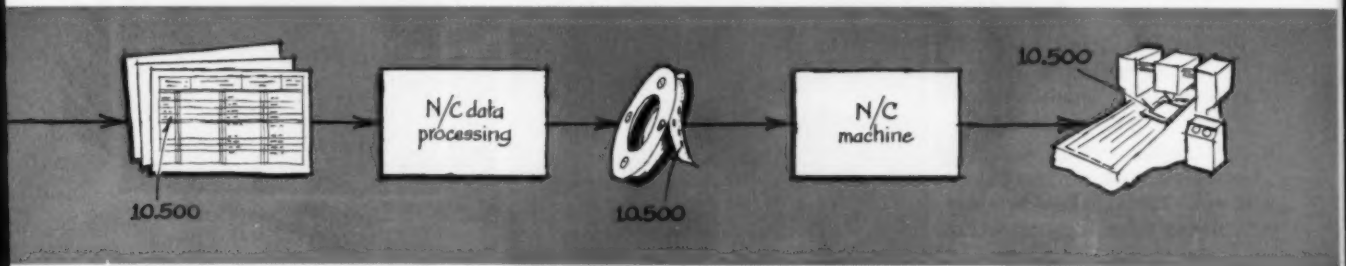
Many small job shops are buying numerical control equipment—mainly the less complex discrete positioning systems. Both price and ease of programming influence this choice. However, there are a few small companies who are investing heavily in continuous path, three-dimension machines.

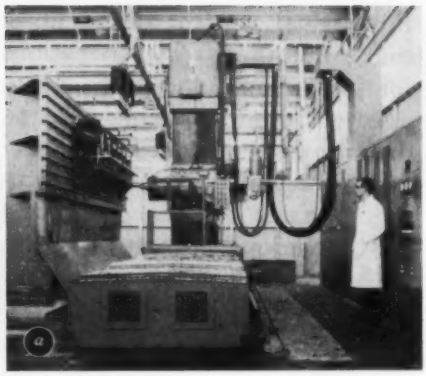
▶ Production Records Impressive

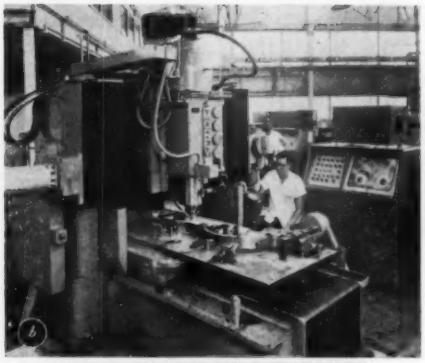
Since many firms are not willing to discuss their operations in public, it is not possible to generalize too much on the results obtained so far through numerical control. My remarks are based upon experience in a specific environment—that of a large aircraft subcontracting firm. However, the nature of our work is such that this experience should be a reasonable parallel to that of many prime contractors and larger job shops.

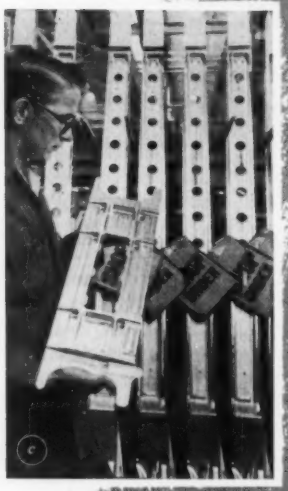
A recent report on the first full production year for five of the numerically controlled mills showed some significant results. The machines involved were three Morey vertical profilers, a Giddings and Lewis Variax, and a Cincinnati traveling column. The records showed that, while these machines are numerically controlled and virtually 100 per cent automatic, each has its own individual characteristics. There are, however, some general conclusions that may be valuable. The average number of hours worked per week by each of these five machines was 127.47 hours. Generally speaking, the more hours the machines were operated, the lower became the percentage of total time chalked up to maintenance and the higher the percentage of spindle time recorded. The percentage of setup time was virtually the same on all machines.

Since decision making at the machine tool has been removed from the operator and is now in the form of pulses on the control media, the machine utilization for numerical control is much higher than in conventional machining. Recent studies have demonstrated that numerical control machine utilization is 60 per cent or more, as compared with a maximum of 20 per cent for conventional equipment. This should be kept in mind when planning maintenance. Not only does the numerical control machine require more and better maintenance due to its complexity, but it is operating three times as









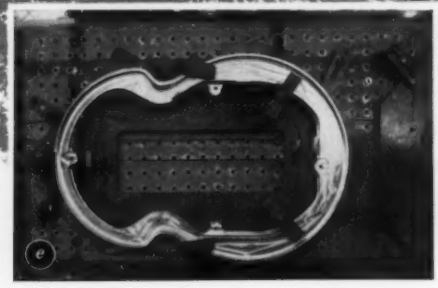


Fig. 2—Photographs indicate a few of the applications of numerical control at Rohr Aircraft Corp.: a. Giddings and Lewis Variax has been in production at Rohr for about 3 years and has turned out thousands of precision parts from a variety of aluminum alloys. b. Engine mounting box beam is being milled on a Morey A-50 profiler from a 4340 steel forging heat treated to 180,000 to 200,000 psi before machining. One simple holding fixture, unique clamping facilities, and a family of 24 magnetic tapes produce a part in 48 hours, floor to floor. c. Two part designs machined from aluminum on the Variax are shown. The blowout door held by operator was milled from stress relieved 7075-T651 plate. Tooling costs for conventional machining were estimated at $26,000; holding fixtures required to machine the part by numerical control cost $800. Engine mounting longerons in background were milled from 7075 die forgings. Conventional machining on this part resulted in a heavy scrap rate that has been eliminated under numerical control. d. Numerically controlled profiler turns out these manifold bleed air flanges from 347 Cres stainless steel. Tooling lead time and costs were reduced by manufacturing both holding fixture and part on same machine. Only 24 hours elapsed between start of the tooling program on this part and completion of the tool. e. Partially milled bulkhead is shown in fixture. Numerical machining results in substantial weight and cost savings. Machined bulkhead replaces 80 sheet metal details and the tooling to manufacture and assemble them. f. Numerically controlled milling of the templates for this "erector set" master model buildup produced closer tolerances and an 80 per cent reduction in span time.

effectively as the conventional machine.

So far as we can ascertain, our results compared quite favorably with those of other companies operating similar machines. It was also evident from the report that the operating time could be improved through a better flow of parts, fixtures, cutters, control media, etc.

Some General Considerations

Very practical considerations for the company undertaking numerical control operation for the first time are the capabilities of machines in relation to materials to be milled. The first generation of numerical control machine tools was made up largely of machines designed to mill light aluminum alloys. Only a few were built to stand heavy steel cutting. As a result, companies that were forced by customer requirements to mill hard steel on numerical control machines encountered difficulty in lack of machine rigidity. This condition is being corrected in the second generation of machine tools.

Our experience at Rohr also has proved the feasibility of in-plant development of programming systems. Our initial programming was based upon the use of a small computer—the IBM 650—and we were able to develop thoroughly workable systems with this equipment. More recently we have shifted to a medium size computer—the Remington Rand Solid State 80 Univac—and have developed our own programming for this computer. My point is that a wide range of two-dimensional and three-dimensional parts were programmed with only occasional access to a large computer. Naturally, when a small computer is used more effort goes into the part programming.

The computer program now in use at Rohr has two-dimensional and three-dimensional capacity. By two-dimensional, we mean that the part is flat or has pockets with various heights and is contoured only in one plane. We consider three-dimensional a part with any configuration in three-dimension swarf surface, etc., as long as the surface can be generated by use of an end mill, ball end mill, or similar cutter.

Rohr's operations also showed some other considerations involved in introduction of numerical control. A company planning to embark upon this program must be prepared to make substantial expenditures for equipment and other initial costs. Because of the high initial cost of numerical control machines and other equipment, management should plan to utilize the machines on a three-shift basis seven days a week. Since processes are controlled completely by the control media, it is possible to schedule work more closely than with conventional machines.

Conventional inspection methods may become a bottleneck for parts produced by numerically controlled machines. This becomes acute when numerical control manufactures a part and a prompt and accurate answer is needed from Inspection to determine whether or not the control media is correct. Possible solutions are use of numerical control equipment in the inspection department, or performance of inspection functions on the numerically controlled production machines.

Another observation resulting from experience with numerical control is that the efficiency of these machines seems to be infectious. There is a tendency to plan more thoroughly in connection with numerical control operations than is likely with conventional machines. The machines tend to change the atmosphere about them by forcing more effective operations in associated functions. This, of course, can be an important factor to management.

Management control also is abetted by a more efficient reporting system possible with numerical control. In order to charge the utilization of machines accurately, Rohr provides the operator with a log. This log contains blocks to be filled in by the operator and countersigned by the supervisor at the machines. Information on production, downtime, electrical or mechanical maintenance, and control media proofing are accounted for on the log. This information is used to plot charts, which can be evaluated during the year and combined into comprehensive yearly reports for top management. Evaluation of this data allows management a clear picture of the operation and an opportunity to take positive steps to remedy such problems as excessive downtime. It is also possible to make comparisons with national figures and appraise the relative effectiveness of the operation.

Scheduling, too, is more easily controlled in numerical control operations, since manufacturing times on a given part can be forecast more accurately than with conventional machines, where the human element often exerts a wayward influence.

Equipment Selection

Selection of equipment is, perhaps, the most important decision facing the management of a company starting in numerical control. Management must, of course, be aided by personnel familiar with the production needs, but no intelligent selection of equipment can be made until management has analyzed its own future plans in terms of the types of equipment available. Equipment such as this is too expensive to be purchased with only immediate needs in mind.

There are three basic approaches to numerical control equipment. These are: 1. Purchase new equipment and control systems. 2. Retrofit existing equipment with purchased control systems. 3. In-plant development and construction of both machine tool and control system.

With the variety of advanced equipment available today, and the improvements resulting from several years of experience, it should be possible to acquire machine tools and control systems suited precisely to the jobs at hand—and with features devised for better maintenance percentages.

Buying new equipment has obvious advantages. Generally, the machine tool and the numerical control system are well balanced and adapted to each other. Often it is possible through investigation to

determine the experience of other firms with similar equipment and thus appraise the suitability for the program at hand. Costs, of course, are the primary obstacles on this path.

There are good arguments on both sides of the question of retrofitting existing equipment. The best argument in favor of this method, of course, is that numerical control equipment can be added to good, conventional machines at a reasonable cost. Some companies have been very successful in this. The job has to be planned and carried out with extreme care, however. After selecting the right machine and modifying it to get the responsiveness and load bearing capability needed for numerical control, the control system must be selected and installed with equal care. It is necessary to have a thorough understanding of the machine tool and the control system to follow this course successfully.

A most courageous course—and one that can produce solid benefits—is in-plant development of an entire numerical control system. Obviously, this calls for experienced personnel thoroughly familiar with all aspects of numerical control. We have accomplished this at Rohr with surprisingly satisfactory results. After developing our control system, we started retrofitting several machine tools for use with this system. But this program did not commence until we had gained extensive experience with standard systems and machines.

▶ The Programming Decision

When management has reached a decision on the equipment to be installed, an even more difficult set of alternatives arises. How are these machines to

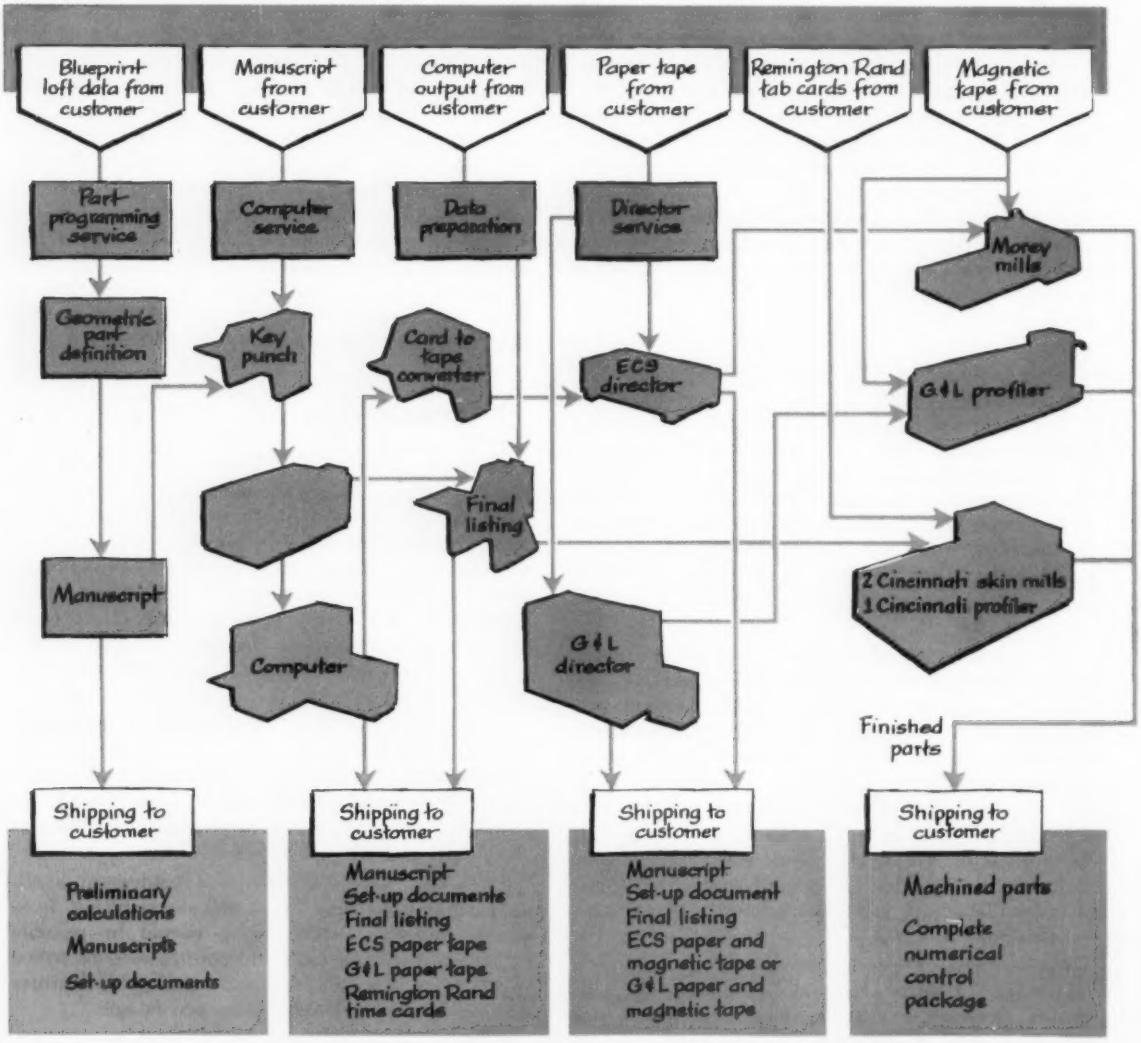
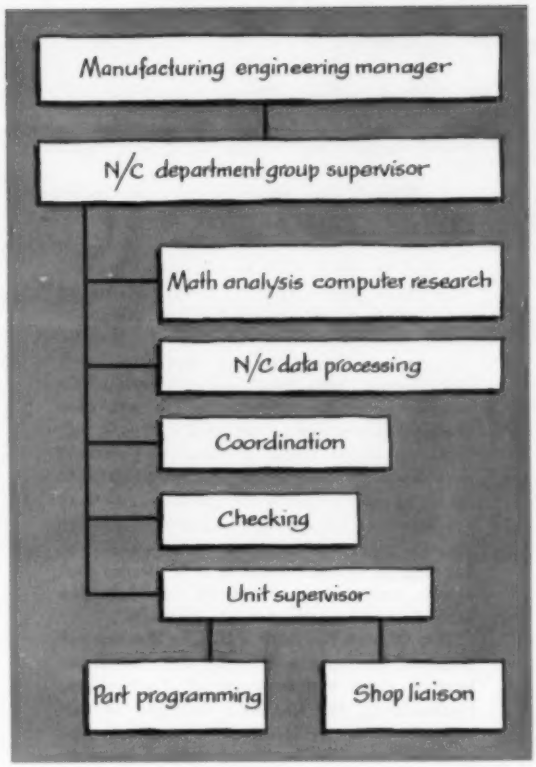


Fig. 3—Schematic block diagram indicates variations in programming and production services which can be purchased by customers to operate their own machines or obtain finished parts.

Fig. 4—Diagram depicts organization used for the Numerical Control Dept. at Rohr. Proper organization can be the most critical factor in the success or failure of a numerical control program.



be programmed? Basically, there are only two ways to go. These are utilization of available numerical control programming services or establishment of in-plant programming facilities.

Numerical control programming services are offered by several companies. Rohr and the Wichita Div., Boeing Airplane Co., are among the best known of these. Several machine tool and control systems builders also offer programming services. Purchase of this type of service will give not only control media, use of computers, and use of data processing equipment, but also the advantages of years of experience in programming selection of feeds and speeds, tooling considerations, planning, and scheduling. It is possible to buy all or any part of the programming sequence. A customer may send a blueprint and receive control media ready to go to the machine tool. On the other hand, it is possible to buy only the programming phase, manuscript writing, computer phase, or any combination of these, *Fig.* 3.

There are, of course, many companies who prefer to establish in-plant programming facilities. This is a step involving many serious considerations both as to equipment and to personnel. A close look at numerical control operations will show human and mechanical processing techniques requiring the skills of several individuals in related but different fields. The processes call for a high degree of organization and maximum utilization of the various technical personnel required if the program is to be efficient and economically feasible.

At Rohr we have developed an organization that separates technical responsibilities into well defined areas. This clear division of functions has the following advantages:

1. Selection of personnel is easier. Most companies already have in their employ men who have the technical skills and knowledge to adapt to numerical control.

2. Training need not be so comprehensive. Emphasis may be placed upon specific applicable areas.

3. Concentrated attention to the problems of each phase simplifies the operation and makes for absolute solution of problems.

4. Each part program receives the benefits of a team of specialists.

5. In such a project-type department, supervisory personnel get the full story faster.

▶ Department Organization

Organization of a numerical control department can be the most critical factor in the success or failure of a numerical control program. Of course, each company will arrive at its own most workable solution to this problem, but I feel there is considerable merit in the organization we have devised at Rohr, *Fig.* 4. At least it is an organization and a system that is proved through several years of operation and may be of help to anyone on the verge of entering numerical control. This organization is unique in its division, but we feel it has been responsible for the rapid development of numerical control in our company.

Math Analysis Group. Successful and comprehensive computer programs can be developed only by qualified personnel who concentrate fully on the problems encountered in the automatic programming of machine tools. The math analysis group in the numerical control organization is responsible primarily for establishing the computer programs needed for computation of data to produce machine tool control media. Therefore, the numerical control mathematician must co-ordinate with part programmers in analyzing part configurations. This avoids violations of computer limitations. The mathematician also must have time to assist part programmers in the analysis of mathematically defined engineering configurations and provide instruction on the use of special computer routines.

Data Processing Group. The volume of data processing required for the operation of numerically controlled machine tools makes it advisable to establish a group responsible only for the processing of numerical control data. Such specialization ensures prompt analysis of processing requirements and tends to reduce lead time.

Co-ordination Group. A numerical control department should function basically as a "make" de-

THE AUTHOR

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Mr. Olesten has both a B.S. in Mechanical Engineering, and a B.S. in Internal Combustion from the Institute of Technology, Gothenburg. He has also engaged in advanced studies in electronics, acoustics, optics, and management, and holds a number of patents in optics, acoustics, and numerical control.

partment. As such it will have direct impact upon the various technical groups that normally service manufacturing departments. Such technical groups can be an asset to numerical control only when their responsibilities have been defined. A co-ordination group must determine the areas of need, assemble the necessary material, and produce the manuals needed for plant-wide indoctrination to numerical control.

Checking Group. The proved economic advantages of numerical control may be offset if the human error that is certain to appear in part programs is not detected before it is incorporated into the machine control media. Numerical control checkers must examine each phase of the part program as a safeguard against such errors.

Part Programming Group. Part programmers are concerned primarily with the conversion of engineering information into a form suitable for the numerical control process. The selection of parts suitable for numerical control milling must be delegated to the part programmer, at least until experience has dictated reliable criteria.

Liaison Group. Actual machining of the first article is the only real proof of the accuracy of a numerical control part program. The primary function of the liaison man is to observe the control media proofing at the machine tool. His analysis of this operation results in a feedback of suggestions for part program improvement and thus greater efficiency in the over-all operation.

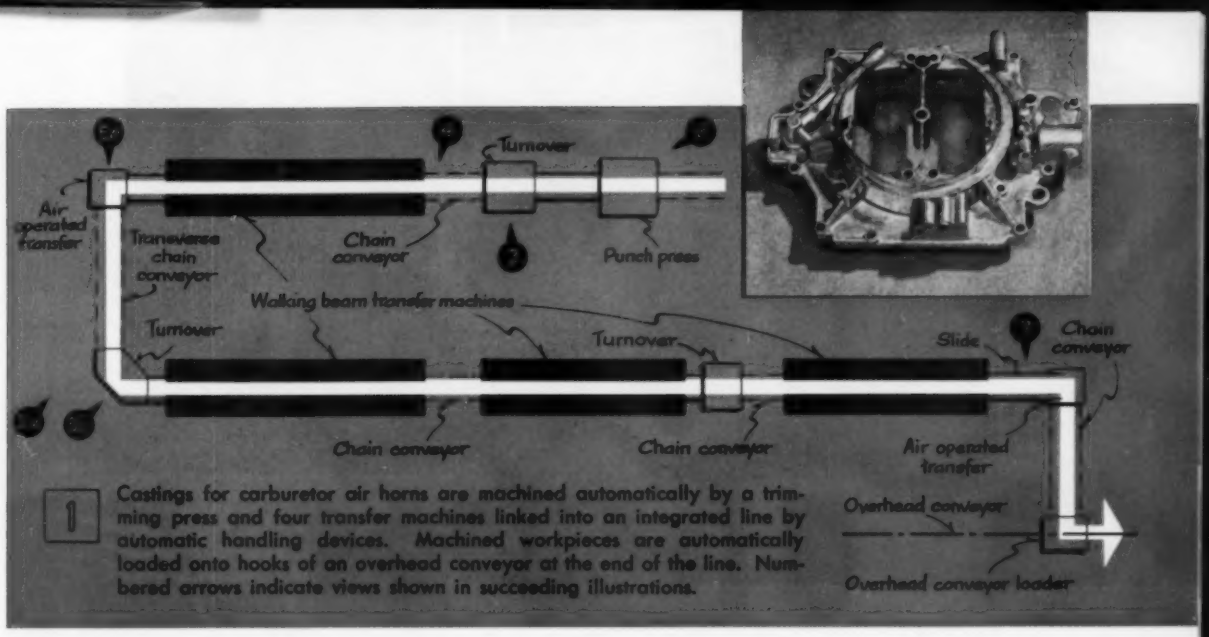
▶ Costs of Programming

Since this discussion is intended to deal primarily with management aspects of numerical control, and no management can avoid consideration of costs, a rough cost evaluation may be helpful. This, of course, is a cost estimate based upon the experiences of one company, and there are obvious shortcomings in its application to any other firm. It does not specify the machine tools, computers, or data processing equipment which may be involved. The following cost breakdown is based upon these assumptions: Five machines have been purchased and installed in the plant and they are to be used on a three-shift, seven-day basis. Both two-dimensional and three-dimensional parts are to be programmed. Manpower for part programming is based upon 75 per cent pure production and 25 per cent manufacture of tools, templates, fixtures, etc. An established computer program has been purchased or is available without cost, and a medium size computer with card or magnetic tape output is to be used. With these conditions assumed, the costs should run something like this:

1. Payroll.
   a. Ten experienced part programmers, including two trainees, at an average of $550 per month each.
   b. One mathematician at $750 per month.
   c. Two data processors at $360 per month.
   d. Two liaison men (two shifts) at $550 per month.
   e. One supervisor at a salary roughly comparable to that of a planning supervisor in a conventional machine shop.
2. Equipment costs for part programming support.
   a. Computer usage, $2400 per month.
   b. Two keypunch machines, 80 and 90 column, $200 per month.
   c. Card-to-tape converter at $115 per month.
   d. Tape-to-card converter at $115 per month.
   e. Magnetic tape director time at $400 per month.
   f. Materials—cards, tape, etc.—$300 per month after the initial buildup of magnetic tapes.

This is a very rough cost evaluation, but it may serve to give management an idea of what may be expected when contemplating numerical control operations. It also may be a factor when weighing programming services against in-plant programming.

This article has not attempted to justify, or sell, numerical control. I feel that this approach to manufacture has sold itself through its own performance in those situations where its capabilities can be exploited to advantage. Results of the first experimental years have shown quite clearly that this approach pays off handsomely when employed properly. However, this is a complex and sometimes confusing field, thoroughly understood by relatively few. Since it involves heavy expenditures, and since its virtues are applicable only under just the right circumstances, it should be approached with great care by management.



1 Castings for carburetor air horns are machined automatically by a trimming press and four transfer machines linked into an integrated line by automatic handling devices. Machined workpieces are automatically loaded onto hooks of an overhead conveyor at the end of the line. Numbered arrows indicate views shown in succeeding illustrations.

AUTOMATION TODAY

HANDLING AIR HORNS FOR MACHINING

MAJOR COMPONENTS of most automotive carburetors are zinc alloy air horns. These are fairly complex die castings made in several different patterns though generally similar in size and shape. In the manufacture of large numbers of carburetors, Rochester Products Div., General Motors Corp., performs many machining operations on each air horn casting with efficient methods of handling and processing.

Machining of air horns is accomplished by a trimming press and multiple machining stations on four walking beam transfer machines. Tools used are chiefly drills, taps, reamers, and spot facers. They are operated by packaged heads or by precision spindles mounted on hydraulically operated slides.

Each of the transfer machines is an in-line unit, automatically fed from preceding operations, with automatic transfer between stations and automatic discharge. After an operator loads the die castings into the trimming press, they require no manual handling during complete machining operations and loading onto an overhead conveyor. Operators merely check the stations, making such adjustments and tool changes as are needed to keep the machines producing at high rates.

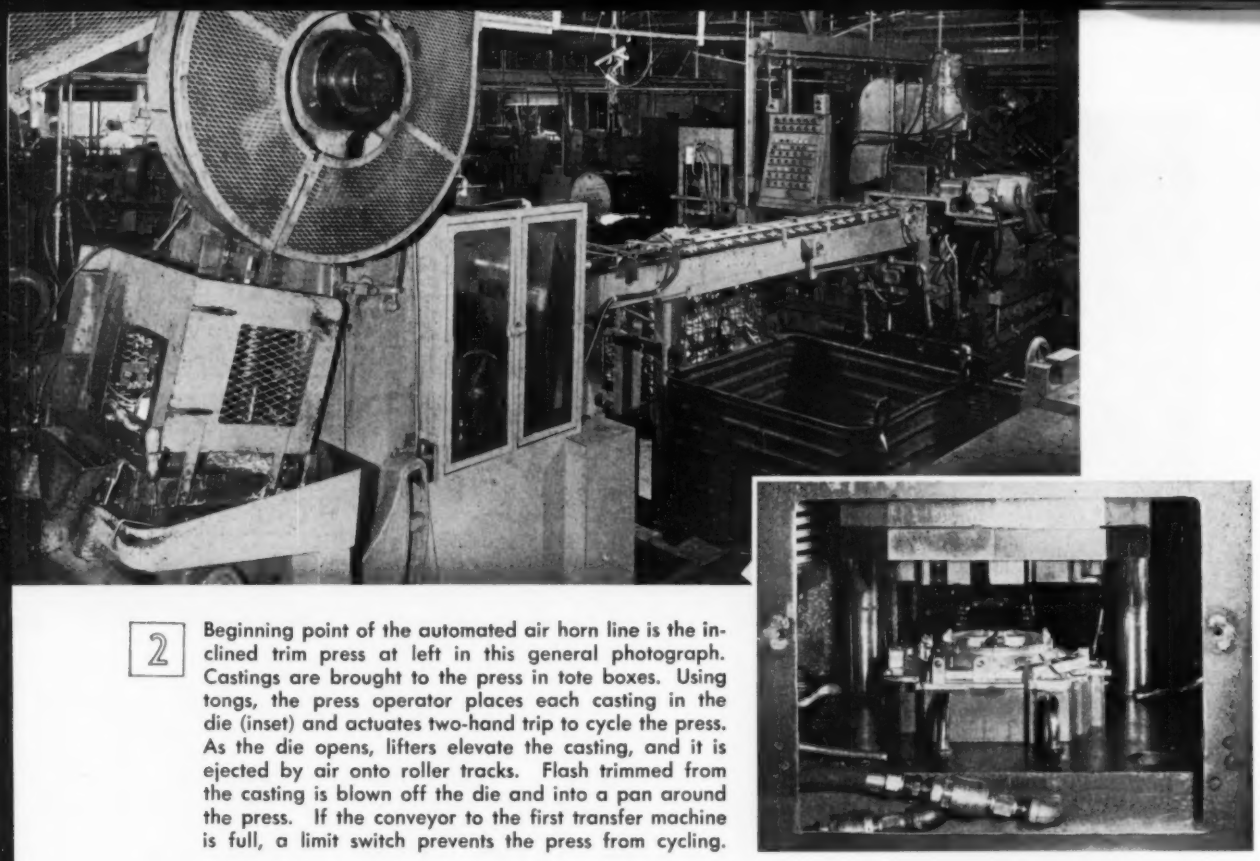
Four in-line machines were used to avoid too many stations in a single unit. For convenience the line is laid out in an out-and-back arrangement of two parallel lines connected by a transverse conveyor.

Workpieces are handled between the machines in the line by chain conveyors, three turnover mechanisms, and two air-operated transfer slides. Final station on the line is used to automatically load finished parts onto hooks on an overhead conveyor.

The chain conveyors in the system use belts of silent chain. The relatively flat back of the silent chain serves as the carrying surface for the workpieces. While the line is in operation, these chain conveyors run continuously. When workpieces must wait for stops to release them from a chain conveyor, the chain simply slips under accumulated parts.

Turnovers are used at three points on the line to present desired faces of the workpiece uppermost in succeeding stations. One turnover mechanism also performs a transfer function between two lines of travel which are at right angles to each other. This turnover takes workpieces from the transverse conveyor and positions them for the second transfer machine.

Air-operated transfer slides move workpieces from the first transfer machine to the transverse conveyor and from the discharge slide of the fourth transfer machine to the final chain conveyor. These trans-



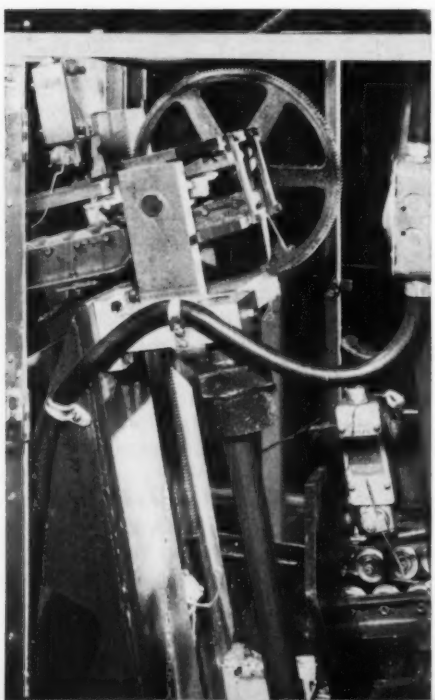
2 Beginning point of the automated air horn line is the inclined trim press at left in this general photograph. Castings are brought to the press in tote boxes. Using tongs, the press operator places each casting in the die (inset) and actuates two-hand trip to cycle the press. As the die opens, lifters elevate the casting, and it is ejected by air onto roller tracks. Flash trimmed from the casting is blown off the die and into a pan around the press. If the conveyor to the first transfer machine is full, a limit switch prevents the press from cycling.

fer slides are controlled by limit switches, and the one for the transverse conveyor is also interlocked with the first transfer machine.

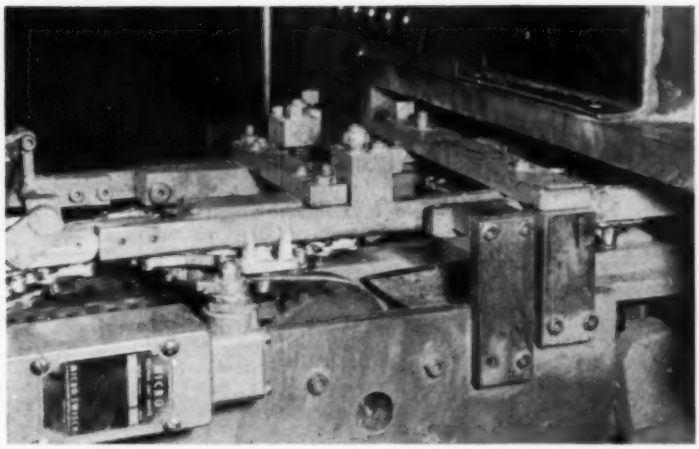
Movement of workpieces from station to station within the transfer machines is accomplished by walking beam mechanisms. These indexing mechanisms advance parts one station at a time, drop away from the parts, and retract. When the machining components have cycled, the walking beam elements rise, engage the parts, and index them forward again.

Orientation of the castings is maintained throughout the line by four lugs on each workpiece. The lugs are kept in proper orientation by rails which extend through the transfer machines and along the conveyors. Final location of the workpieces in machining stations is accomplished by pins entering two work holes which are cored in the castings. When parts have been properly positioned in the machining stations, they are clamped by hydraulically operated elements during the machining operations.

Accompanying sketches and photographs show machines and handling arrangements used in this line for machining carburetor air horns. Although the conveying and transfer system described may give an over-all impression of complexity, all the units involved are basically simple and yield desired results without undue attention.



3 Immediately behind the trimming press is this elevating turnover mechanism. Trimmed castings enter the turnover from the press by means of the roller tracks at lower right. The part stops in a nest which is raised by a cylinder, and during the upward stroke the nest is rotated approximately 180 degrees by a rack and gear arrangement. When the nest reaches the top of its travel (as shown in photograph) the inverted casting moves down the roller conveyor at upper left to a chain conveyor.



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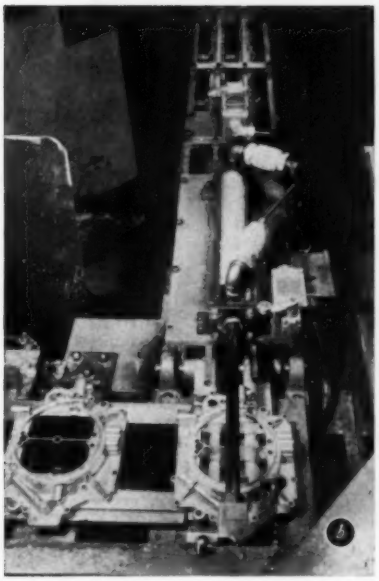
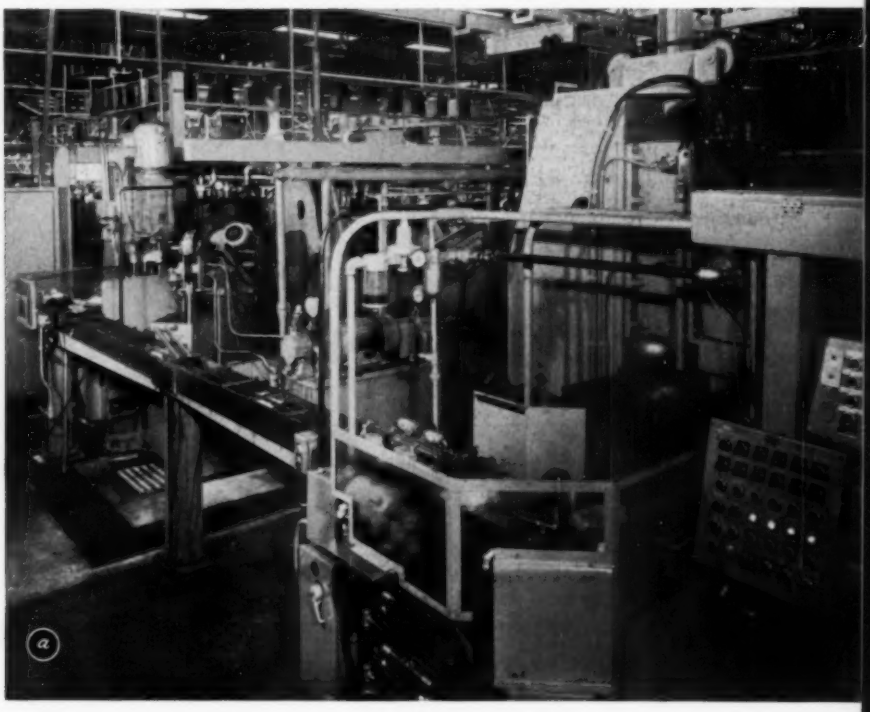
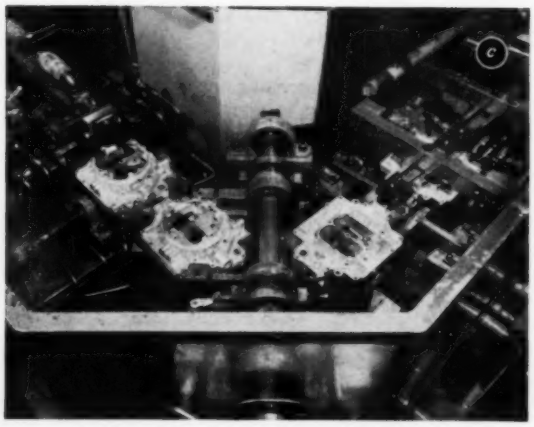
Trimmed workpieces advance from the turnover on a constantly running chain conveyor. Silent chain is used with the parts riding on the back of the chain. The swinging stop at extreme left in this photograph is actuated by a pneumatic cylinder to release parts to spring-loaded fingers above the chain sprocket at center. The limit switch in the foreground senses whether or not a part is in position against the spring-loaded fingers and controls the cylinder for the swinging stop. When the walking beam mechanism of the first transfer machine advances, it carries the workpiece past the spring-loaded fingers and into the machine at right.







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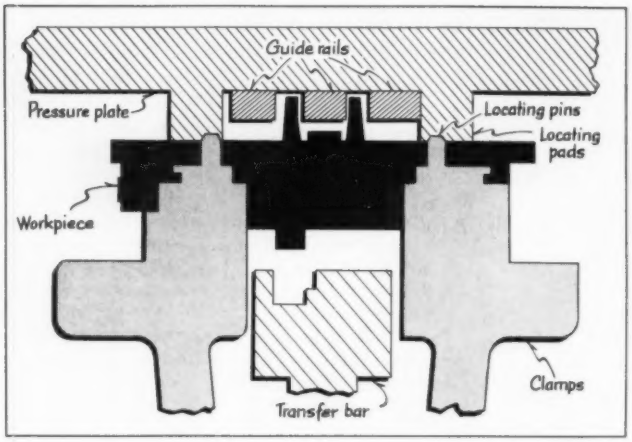
Coming from the first transfer machine, at left background in general photograph *(a)*, the workpieces are moved by the transverse chain conveyor to the second transfer machine at right. Photo *(b)* shows parts as they are moved along rails at lower right by indexing mechanism of first transfer machine. The air cylinder slides castings one at a time onto the transverse conveyor. Photo *(c)* shows turnover device that transfers air horns from transverse conveyor at left and places them for advance into second transfer machine at right. The cylinder above the transverse conveyor slides a workpiece into the turnover fingers when it is actuated by a cam timer on the transfer machine. The turnover mechanism clamps the part as the cylinder retracts. When the walking beam mechanism on the transfer machine is in its lower position, the turnover rotates to place the part in position to be engaged by the walking beam mechanism on its next advance.



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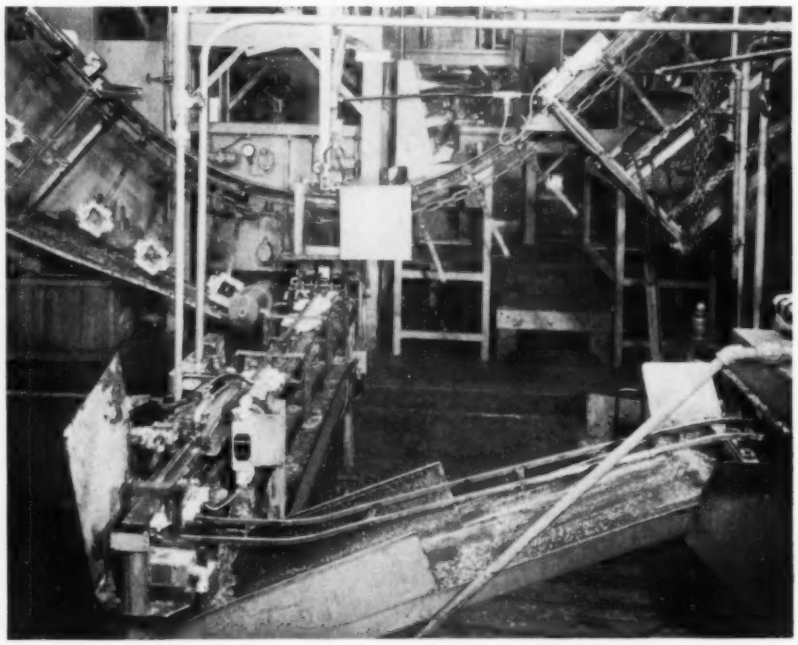
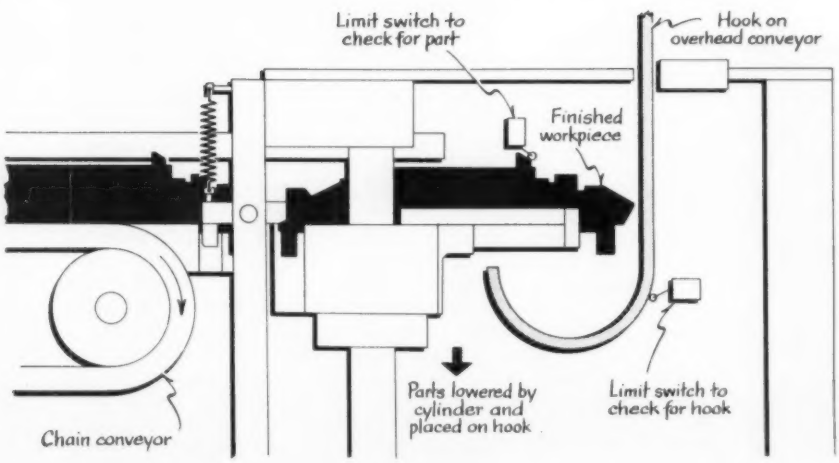
Sketch indicates typical handling elements in stations of the transfer machines. Workpiece is shown in clamped position with walking beam transfer bar in its down position. Before the clamps are lowered the transfer bar will be raised. During transfer the top surface of the casting is approximately 1/32 inch below the locating pads on the pressure plate.

7

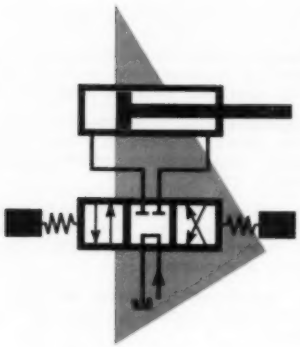
Machined castings are discharged from the fourth transfer machine at right and slide down rails to the air-operated transfer device at lower left. This transfer slides the parts onto a chain conveyor that carries them to the station where they are automatically loaded on the hooks of the overhead conveyor shown running from right to left in the background.




Limit switch to check for part
Hook on overhead conveyor
Finished workpiece
Parts lowered by cylinder and placed on hook
Limit switch to check for hook
Chain conveyor

8

View of automatic hook loading station is sketched as it appears looking along the overhead conveyor in its direction of advance. A cylinder lowers the finished part onto the conveyor hook when limit switches sense simultaneous presence of workpiece and conveyor hook. Succeeding workpieces are stopped on chain conveyor by simple spring and lever arrangement while lowering platform is down.



Part 1

BASIC SEQUENCING METHODS

INDUSTRIAL HYDRAULIC CIRCUITS

Advantages of hydraulics as a means of producing motion and force, and its adaptability to many methods of interlocking and sequencing related machine movements, are becoming increasingly recognized in industry. Because of the versatility of hydraulics, several alternate circuits can often be devised to produce a desired result. However, when major factors such as cost, space, simplicity, safety, and maintenance are considered, there is usually one best approach for a given application. In this first part of a series on industrial hydraulic circuits, the author describes available components for controlling the basic factors of time, velocity, position, and force and compares practical circuits for sequencing actions of one cylinder.

By **JACQUES CARPENTER**, Industrial Products Dept., Vickers Inc., Detroit, Mich.

SEQUENCING of machine members usually involves control of four basic factors, namely: Time, velocity, position, and force. For example, a machine slide may be required to move at high velocity to a predetermined position. It may then have to move at a lower velocity to a second position while supplying a desired force. After a preset dwell period, the slide may return at high velocity to the starting position.

This sequence of events comprises the familiar *Rapid Advance, Feed, Dwell,* and *Rapid Return* cycle used in many machining operations. Where a machine is controlled hydraulically, such a cycle is easily achieved through the use of circuits that control the basic factors of time, velocity, position, and force for one or more actuators.

For each basic factor a number of control devices is available. Operating principles, performance characteristics, and typical applications of several commonly used devices are outlined in TABLES 1 through 4. A given machine system may employ a mixture of such devices—electrical, mechanical, pneumatic, and hydraulic pilot-operated—depending upon the application and the basic factors involved.

Sequencing One Cylinder

Perhaps the simplest hydraulic sequencing circuit for a single cylinder is the one shown in *Fig.* 1*a*. Here, a 4-connection, two-position directional control valve provides two directions of movement and two positions (one at each end of a cylinder). By substituting a spring-centered, three-position valve

TABLE 1—Characteristics of Some Common Types of Time Control Devices

Device	Operating Principle	Normal Delay Interval	Typical Applications
Hydraulic Time Delay Relay Valve	Hydraulic dashpot.	0 to 3 seconds	Assembly and other automated machines operating in hazardous or explosive areas where electrical controls may not be used.
Choke Adjustment on Pilot-Operated Directional Control Valve	Controlled rate of flow of pilot fluid to delay shifting of valve spool.	0 to 3 seconds	Inexpensive and convenient means of providing dwell at start and end of machine motion. Also provides smooth starting and stopping action.
Electrical or Electronic Timer	Synchronous motor-driven or electronic timer operated contacts.	Any interval	Injection and compression molding machines, diecasting machines, presses, machine tools, etc., where precise, adjustable time interlocking is required.
Pneumatic Time Delay Relay	Controlled rate of flow of air in chamber to delay relay operation.	0 to 3 seconds	Any automated sequence requiring a controlled dwell period at start or end of a motion.
Motor Driven Cam Control	Rotating cams actuate hydraulic or electrical components.	Any interval	Central programming control for various types of multifunction machines.

TABLE 2—Characteristics of Some Common Types of Velocity Control Devices

Device	Operating Principle	Flow Range*	Typical Applications
Needle Valve	Variable restriction (usually can be adjusted manually).	0 to 325 gpm	Widely applied in many types of applications where inexpensive speed control is adequate.
Fixed Orifice	Nonadjustable restriction.	0 to 325 gpm	Used where fixed speed is permissible or where tampering with control is undesirable.
Deceleration Valve	Mechanically adjustable restriction.	0 to 65 gpm	Cushioning of slide or rotary table motions.
Flow Control Valve	Manually adjustable restriction. May be pressure and temperature compensated.	0 to 65 gpm	Tool feeds and other applications requiring accurate control of speed.
Double Pump Arrangement	Two selectable sources of hydraulic flow.	1 to 120 gpm	Dual speed applications where stepped speed change is acceptable. Frequently combined with flow control valve for rapid traverse and adjustable feed action.
Variable Delivery Pump	Variable source of hydraulic flow.	0 to 500 gpm	Applications requiring wide speed ranges with good efficiency. Used for conveyor drives.
Variable Displacement Fluid Motor	Rotational speed varies directly with displacement.	0 to 500 gpm	Constant horsepower drives for spindles, lathe heads, tapping heads, etc. Also rewind drives for metal, paper, and textile machines.

*Flow range is that for all devices in a class. An individual unit will not usually operate over the entire range.

TABLE 3—Characteristics of Some Common Types of Position Control Devices

Device	Operating Principle	Approximate Maximum Positioning Accuracy*	Typical Applications
Mechanical Stop	Fixed or adjustable stop against which a movable machine member can come to rest.	0.0002 inch	Where position must be accurately established and maintained.
Dog	Movable mechanical element.	.....	The dog usually operates a switch or valve so as to cause the flow of oil in an actuator to be stopped or reversed. This action occurs at a predetermined position.
Limit Switch	Mechanically tripped electrical switch.	0.005 inch	Limit switch is electrically interlocked to a solenoid operated hydraulic control valve. Operation of valve either halts or reverses fluid flow to or from an actuator.
Deceleration Valve	Used as mechanically operated shutoff valve.	1/32 inch	To stop an actuator anywhere in its travel by shutting off the oil supply or exhaust.
Pilot Valve	Small mechanically operated valve.	1/8 inch	Control of continually reciprocating motions as in grinders, planers, feeders, paint sprayers, etc. Also used in interlock circuits where electrical controls are not practical.
Electronic Switching Devices	Photoelectric, proximity, etc., devices.	1/32 inch	Used where direct mechanical contact is impossible or undesirable. Interlocking action is similar to that of limit switches.

*Positioning accuracy depends upon many factors external to these devices. Figures quoted are for comparison purposes and apply under near-ideal conditions.

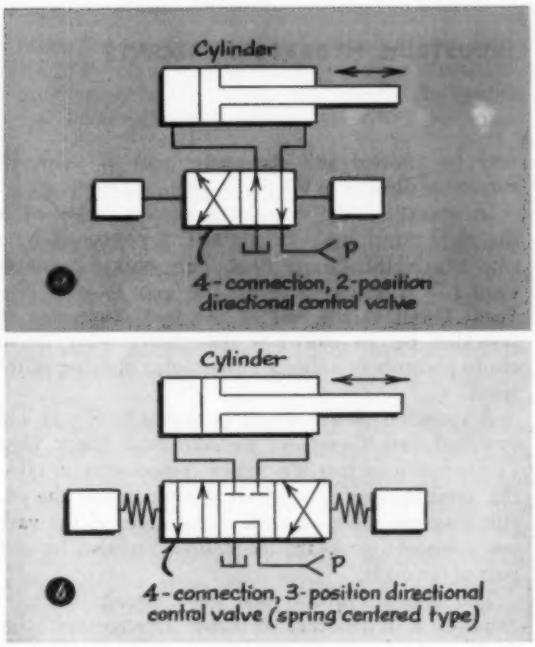


Fig. 1—Control of direction of motion and choice of two stop positions are provided by four-connection directional control valve and actuator, *(a)*. By utilizing a centering type of control valve, *(b)*, any number of intermediate positions may be obtained with the cylinder.

as in *Fig.* 1*b*, the piston may be stopped at any intermediate position as well as at the ends of the cylinder. Operation may be intermittent or it may be continuous as for a grinding machine where continuous reciprocation is desired between a workpiece and a wheel.

A more elaborate sequencing circuit is shown in *Fig.* 2. Used on a honing machine, the circuit provides continuous reciprocating action of a single cylinder. Operation is started when valve *V*1 is actuated to block a pump unloading path. With the components in the positions shown, pressure will then be applied to the left end of the cylinder through *V*2 and the piston will advance to the right. At the forward end of the advance stroke, an adjustable dog on a slide carried by the piston rod will shift the spool of valve *V*3. This will relieve pressure on the lefthand pilot of *V*2 and apply pressure to the righthand pilot of this valve. The valve spool will shift and the piston will receive pressure on its right end with the left end connected to tank. Return motion will begin and continue until another dog on the slide moves the spool of *V*3 to its original position causing the piston to advance. The setting of flow control valve *V*4 determines the speed of reciprocation, and the positions of the dogs control the stroke length and reversal points of the piston. Relief valve *V*5 limits maximum system pressure to a safe value.

Operations such as drilling, milling, and boring require an automatic sequencing cycle that includes *Rapid Traverse* to a given position, *Feed* to a second position (usually a positive stop), *Dwell*, and *Rapid Return* to the starting position. The versatility of hydraulics permits the use of a variety of circuits to provide the *Rapid Traverse* and *Feed* actions. Each circuit has certain advantages and disadvantages with respect to the others.

The circuit of *Fig.* 3 is often used where it is desired to have remote electrical control of the transition between *Rapid Traverse* and *Feed*. An optional *Fine Feed* arrangement is included in the diagram. Where *Coarse Feed* is sufficient, valves *V*3 and *V*4

TABLE 4—Characteristics of Some Common Types of Force Control Devices

Device	Operating Principle	Pressure Range*	Typical Applications
Relief Valve	Regulates maximum system pressure. Can be either adjustable or nonadjustable.	20 to 5000 psi	Basic safety control for all hydraulic circuits.
Pressure Reducing Valve	Regulates maximum pressure in any leg of a hydraulic circuit.	25 to 3000 psi (outlet) 50 to 3000 psi (inlet)	Used in all types of circuits to reduce pressure at a particular point in the system without affecting over-all system pressure.
Sequence Valve	Regulates minimum pressure in any leg of a hydraulic circuit.	0 to 3000 psi	Used to sequence cylinders when limit switch sequence control is not required. Also often used to maintain minimum pressure in one actuator when another actuator is moving.
Pressure Relay Valve	Similar to sequence valve but generally used in pilot lines rather than in main hydraulic lines.	0 to 3000 psi	Miscellaneous pilot line interlock applications.
Pressure Switch	Pressure sensing device actuates an integral switch when pressure attains a preset level.	0 to 5000 psi	Used on presses, etc., to reverse or initiate another action after a predetermined pressure has been achieved. Also used on accumulator unloading controls.

*Pressure range is that for all devices in a class. An individual unit will not usually operate over the entire range.

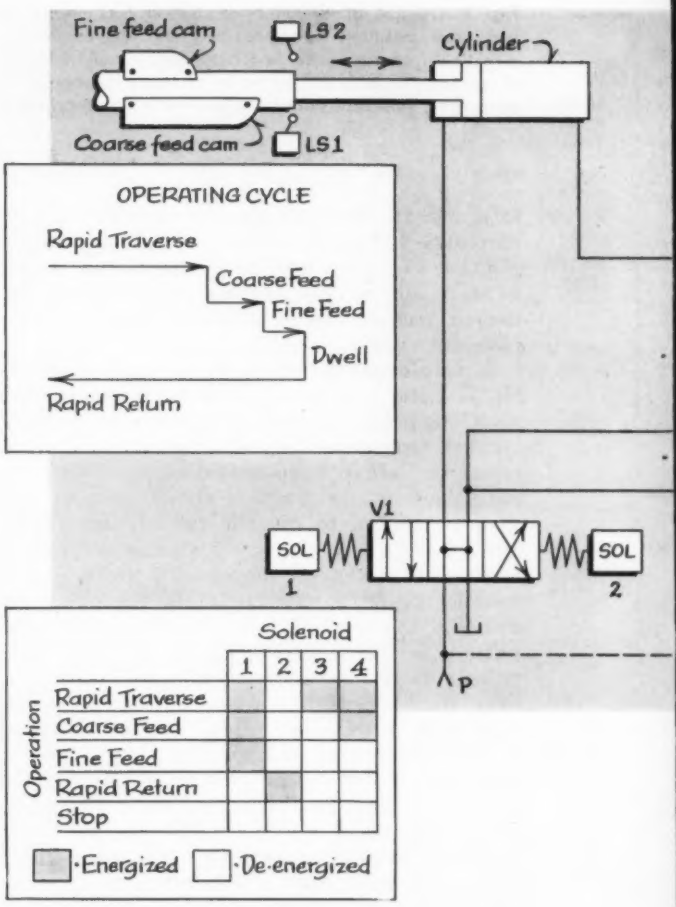
may be omitted and the outlet port of valve *V*5 connected directly to *V*1.

In operation, the cylinder is rapidly traversed to the right until limit switch *LS*1 is contacted by a cam to establish *Coarse Feed*. This motion continues until *LS*2 is contacted by another cam to cause *Fine Feed*. Dwell at the end of the feed stroke can be provided by an electrical time delay relay or by choke controls in valve *V*1 that delay shifting of the spool.

A variation of this circuit is shown in *Fig.* 4. The modified circuit employs an additional check valve (*V*5), but uses two less major components to effect the same actions. The chart accompanying the circuit diagram shows the operating states of the various solenoids to obtain the desired function in each part of the cycle.

The *Rapid Traverse* and *Feed* circuit of *Fig.* 5 employs a differential cylinder arrangement that doubles the speed of rapid traverse in the forward direction without the necessity of increasing pump size. Available thrust during the feed stroke is also unaffected.

With the lefthand solenoid of *V*1 energized, the spool of this valve will shift to a position admitting fluid to the blind end of the cylinder. The cylinder



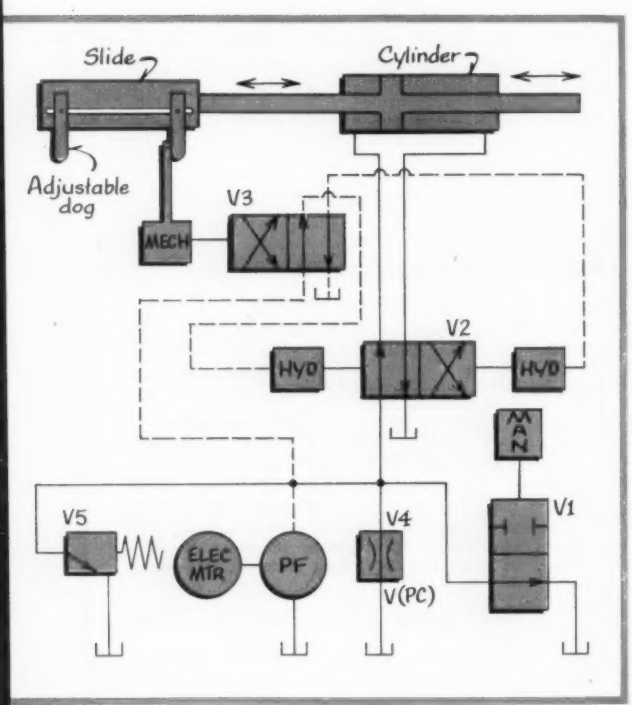


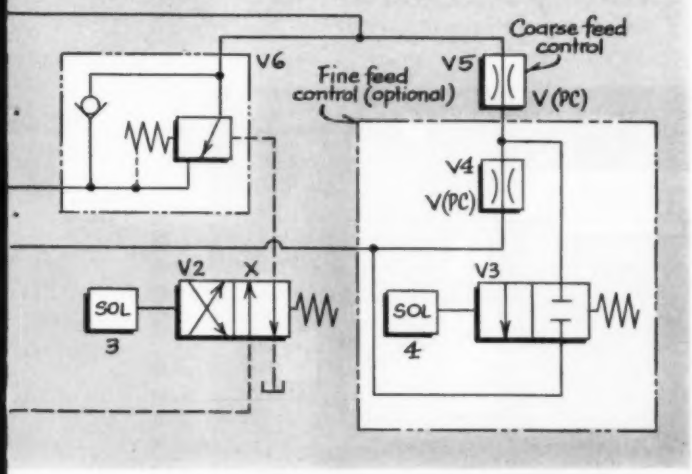
Fig. 2—Continuous reciprocation of one cylinder is provided by this circuit used on a honing machine. Cycle repeats indefinitely when valve V1 is actuated.

is constructed so that the effective piston area on the rod end is one half the area on the blind end. As the piston advances, exhaust oil from the rod end of the cylinder is forced through normally open valve *V*2 and check valve *V*3 to join the pump delivery. The pump, therefore, must add to the blind end only an amount of oil equal to the product of the stroke and piston rod cross-sectional area. With a fixed displacement pump operating at a constant speed, this arrangement moves the piston at a faster rate than would occur if the rod end were connected to tank. A small amount of fluid in the rod end escapes to tank through flow control valve *V*5, but the effect on *Rapid Traverse* speed is negligible.

Positive transition from *Rapid Traverse* to *Feed* is effected when a cam carried by the piston rod depresses deceleration valve *V*2 to shut off the flow path through *V*3. Oil from the rod end then flows to tank through *V*5, putting the stroke in *Feed*. During this period a differential circuit no longer exists and the thrust available for the feed load is that developed by pressure acting on the full blind end area of the piston.

The feed stroke continues until *LS*2 is contacted, at which time the righthand solenoid of *V*1 will be energized to shift the spool of the valve and admit

Fig. 3—Electrically controlled sequencing circuit provides coarse and fine feed control with dwell at end of advance stroke. Cams operate limit switches to shift from rapid traverse to coarse feed and from coarse to fine feed. Chart illustrates energization status of solenoids to effect various operations. Dwell at the end of the feed stroke can be provided by an electrical time delay or by choke controls in valve V1.



pump pressure to the rod end of the cylinder through *V*4. The blind end of the cylinder is exhausted to tank through *V*1. With this circuit configuration the piston will return rapidly.

Packaged Controls

The prevalence of *Rapid Traverse* and *Feed* cycles in industrial equipment makes it practical for hydraulics manufacturers to offer package units in which all necessary valve controls and circuits are combined in one housing. This arrangement provides a neat, compact assembly requiring a minimum of space.

Many variations of the *Rapid Traverse* and *Feed* circuits are possible. A double feed rate panel usually incorporates two metering throttles and provides both coarse and fine feed rates for the working cycle in addition to rapid advance, return, and dwell actions. Although details of design, size of parts, and metered flow rates vary according to the manufacturer, the basic principles of operation are similar for all panels.

One example is the Vickers Inc. CP-06 cycle control panel illustrated in *Fig.* 6. This unit includes a directional control lever, a control shaft, and a valve spool shifter pin. The horizontal position of the lever may be controlled manually, by pilot valve, and by mechanical dogs. The position of the control lever determines the cycle phase at any given time.

Flow controls in the panel include a coarse feed throttle, a fine feed throttle, and a pressure compensator to minimize the effects of pressure variations on either feed rate. The coarse and fine feed throttles have external dials so that precise feed rates can

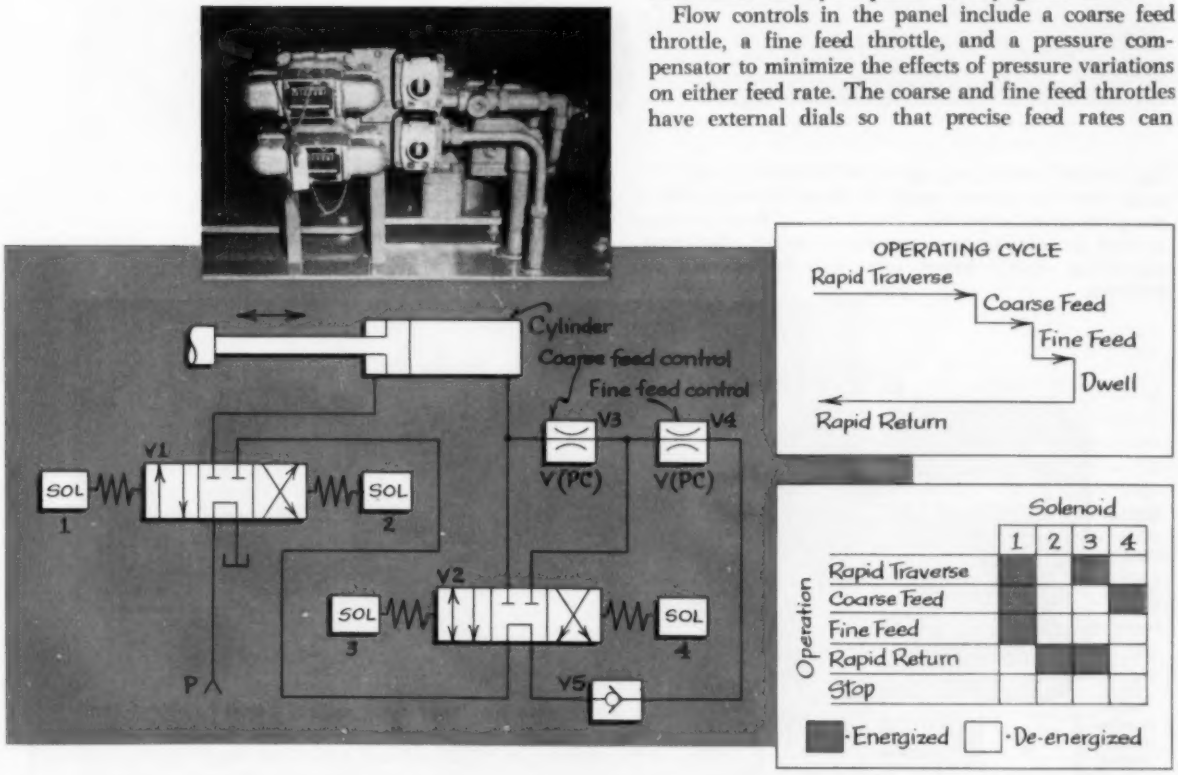


Fig. 4—Variation of sequencing circuit of *Fig.* 3 uses fewer components to accomplish similar cycle. Typical grouping of directional and flow control valves is shown in photo.

be manually preset to any point within the capacity range of an individual throttle.

Part 2 of this series, to cover multiple sequencing circuits, will appear in a succeeding issue. In this second installment, several methods of interlocking and cycling multiple actuators and rotary motors will be explained. Presentation represents a logical extension of principles contained in Part 1 to more complex systems.

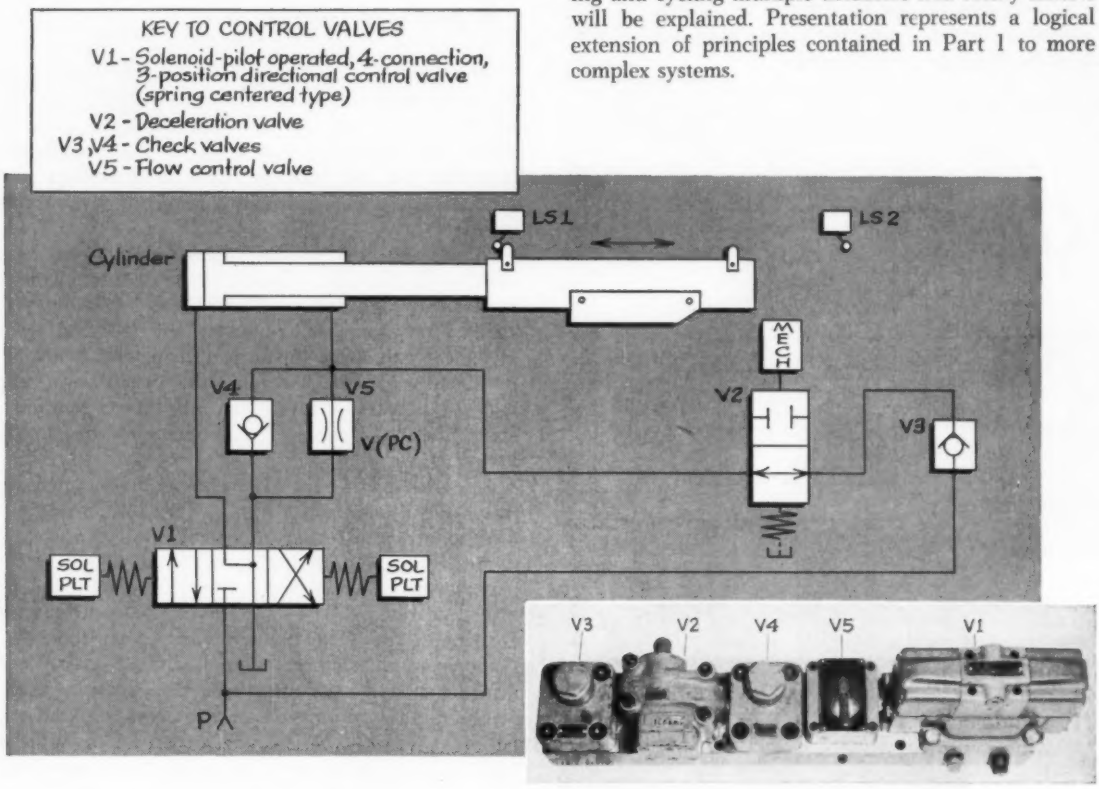


Fig. 5—This circuit employs a differential cylinder arrangement to increase speed of *Rapid Traverse* with a pump of given capacity. Thrust during *Feed* is same as that for conventional sequencing circuit. Sub-base containing control valves, inset, can be mounted on machine.

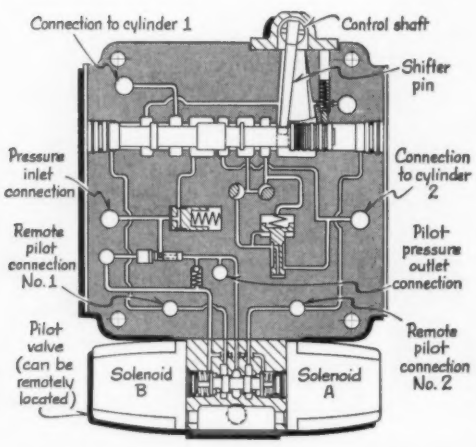


Fig. 6—Traverse and feed cycle control panel combines components and circuits for cycling an actuator through the steps of *Rapid Advance, Coarse Feed, Fine Feed, Rapid Return,* and *Stop.* Feed rates are infinitely adjustable through ranges by means of dials on panel. Unit may be actuated manually or automatically by pilot valve and mechanical dogs. Diagram illustrates internal configuration of unit.

CHECKING TEMPERATURE GRADIENTS IN KILNS

PERIODIC measurement and recording of temperature profiles and gradients in its electrically heated tunnel kilns is an important procedure at Stackpole Carbon Co. Products fired in the kilns include "Ceremag" ferrite cores, ceramic magnets, and other relatively small electrical components that require processing at controlled temperatures in the 2500 F range.

Each kiln is slightly over 100 feet long. In operation, parts to be heat processed are placed on trays on a wheeled kiln car that is advanced through the unit on rails at a predetermined speed. The trays are separated by refractory bricks, and a substructure of refractory bricks supports each load of trays and parts on the car.

A kiln may have as many as eight zones of temperature, each of which must be controlled precisely. Automatic kiln temperature controls include Leeds & Northrup Co. Type H DAT (duration adjusting type) Speedomax controllers. The company also supplied multipoint instruments for temperature monitoring and oxygen equipment for control of kiln atmospheres.

Temperature information gathered during a periodic test is used in several ways. For example, it helps establish the proper distribution of parts on the trays; it assists in the selection of optimum car speeds; and it offers a guide to the settings of transformer taps that determine kiln heat inputs. Temperature data collected during a test also points to the most advantageous settings for temperatures and for the proportioning, reset, and rate actions of the automatic temperature controllers. The test measurements may also give early warning of the need for maintenance of resistance units, thermocouples, and refractories.

A test run involves use of a standard kiln car and trays that are loaded with a typical supply of parts. Thermocouples with platinum, platinum-rhodium elements are mounted on the test car with their heads in the space below a sand seal. The leads from the thermocouples are brought out from the bottom of the car and pass through a flexible, 3/8-inch diameter tube made of Teflon-filled asbestos material. The tube containing the thermocouple leads extends from the car, through the kiln near the charging end, to a Speedomax recording potentiometer. Excess tubing is coiled loosely on a fixture between the recorder and the kiln so that the tubing may be uncoiled and fed into the kiln as the test car is advanced.

As the car moves through the kiln, the tube snakes along a steel trough between the car rails. Ambient temperature in this area is approximately 800 F. The tubing material used to shield the thermocouple leads was selected because it can resist this temperature and because it is relatively unaffected by abrasion due to spilled sand, broken pieces, and bits of refractory material that fall into the trough.

During a test, temperatures are recorded continuously on the chart of the recording potentiometer. An engineer at the instrument may observe the kiln cycle and incorporate notes and comments at appropriate places on the chart.

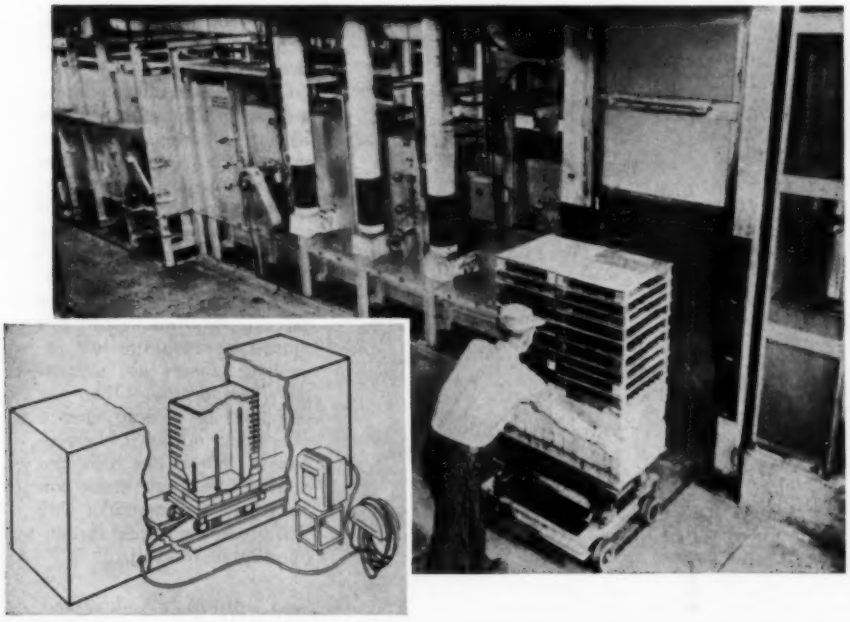


Illustration shows a portion of electrically heated tunnel kiln used to fire ceramic magnets and ferrite cores. Automatic controllers regulate temperatures in each of several zones of unit. For test purposes, a car carrying a typical production load of parts is moved through the kiln. Inset shows arrangement whereby thermocouples on test car are connected through flexible tubing to recording potentiometer.

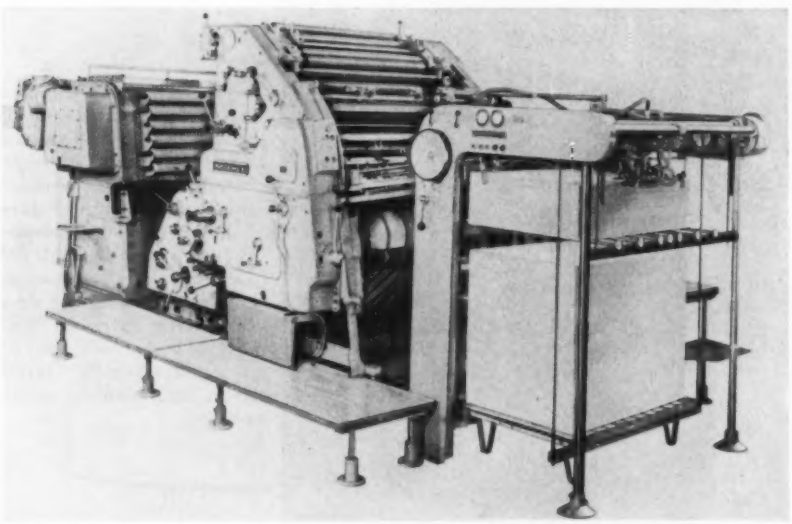
Unique conveyors, stackers, feeders, sorters, and positioners have been developed for the automated handling of paper products during production. To keep pace with automatic processing machinery such devices must be fast, accurate, and reliable. Techniques proved in this industry form a base for other manufacturers to use in solving handling problems.

TRICKS IN HANDLING PAPER PRODUCTS

By **J. R. HUMPHREY**, General Manager, Humphrey Design & Mfg. Inc., Cleveland, Ohio

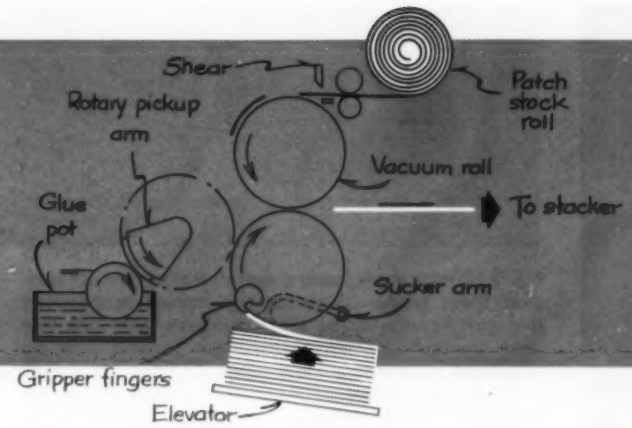
MANUFACTURERS of paper products such as envelopes, labels, bags, printed forms, and publications were among the first to employ automatic handling equipment. The very nature of such products, and their necessarily low prices, demanded high volume production with a minimum of hand labor. The result was development of high speed, automatic handling devices that are fast, accurate, and reliable.

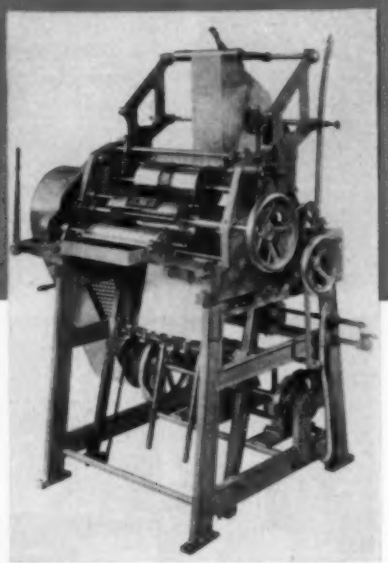
Although some of the paper products mentioned are currently produced on continuous web machinery, there is a growing application of basic sheet handling devices to new paper and other product processing. In many instances it is more practical and necessary



Courtesy, Miehle Co., subsidiary, Miehle-Goss-Dexter Inc.

Fig. 1—Nonstop pile feeder, right, accepts stacks of paper sheets and feeds them continuously to an offset printing press. In operation of the feeder, the top sheet in a stack is lifted by vacuum sucker cups as an air blast "floats" the sheet into feed rollers or conveyor belts. The stack is elevated automatically as the supply is depleted. To replace a stack with the machine operating, rods are placed beneath the last remaining sheets to support them temporarily. Then the pile hoist is lowered, and a new stack loaded in the machine. When the rods are removed, the new stack can be raised incrementally with the preceding stack for uninterrupted feeding.





Courtesy, Pearce Development Co.

Fig. 2—Diagram illustrates major feeding elements of patch machine shown in photo. Machine performs functions such as applying window patches to envelope blanks, inserting foil strips into greeting cards, and applying calendars to bases. In sketch, top base sheet is shown being lifted from stack by a sucker arm. As supply is depleted, sucker arm drops farther by gravity to contact a top sheet. This eventually engages a pawl on the sucker arm with a ratchet on the stack elevator mechanism. Stack is then indexed upward on next cam-operated upstroke of sucker arm. Top sheet lifted by sucker arm is clamped to a rotating drum by gripper fingers and carried past a rotary pickup arm to receive glue. At the same time, a patch is cut from roll stock and carried by a vacuum roll to meet the base stock at the point where glue is applied. Glued assemblies pass through the rolls and are fed to a stacker.

to process individual sheets or units. The development of new papers, films, and foils—along with the resulting development of new products using these materials—has necessitated improvements and higher speeds in sheet handling mechanisms.

Basic paper sheet handling mechanisms are utilized in packaging material manufacturing, packaging and wrapping operations, corrugated board products manufacturing, pressure sensitive tape and label application, bookbinding, and a wide variety of other manufacturing operations. They are used in equipment for printing, coating, gluing, folding, sorting, and collating. The following discussion will serve to describe some of the basic devices used to handle sheets during production.

▶ Elevator Feeders

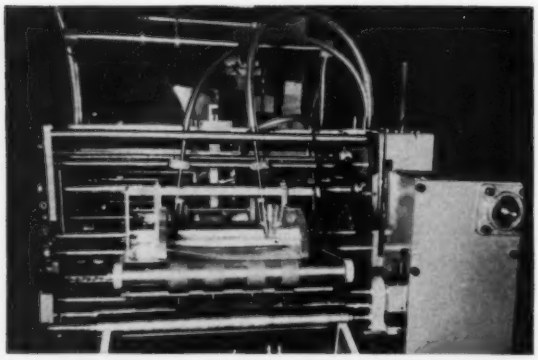
A pile feeder, *Fig.* 1, elevates a paper stack as the sheets are fed off the top of the stack. The sheets are lifted and controlled by the combined actions of vacuum sucker cups and air blasts which "float" the sheets into feed rollers or conveyor belts. Most large pile feeders can be equipped with a nonstop feeding feature whereby the operator can replenish the feeder without stopping the machine. To accomplish this, rods are placed in position to support the last remaining sheets being fed; the pile hoist is lowered; a fresh load of stock is moved into place on the pile hoist; the hoist is raised; the rods are removed; and the new load is ready for continuous feeding without interruption of the production machine.

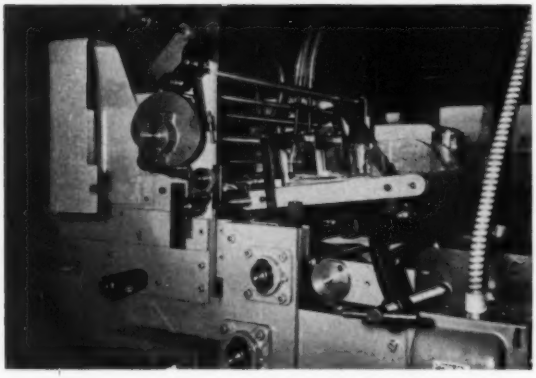
Sheets can be fed singly, in sequence, or stream-fed. Sheets that are stream-fed are arranged in underlapped relation with their leading edges close together. This reduces to slow motion the high-speed feeding of large sheets and requires only short-stroke action of the feeding mechanism.

A small elevator feeder, similar in principle to the large pile feeder, is shown applied to an automatic patch machine in *Fig.* 2. The patcher performs operations such as applying window patches to window envelope blanks, applying calendars to bases, and inserting foil or other strips into greeting cards. The base sheet is fed off the top of an elevated stack by a vacuum sucker arm as shown in the sketch. The sucker arm lifts one end of the top sheet into position to be clamped by gripper fingers to a rotating drum. The glue pattern is then applied to the sheet by a rotary pickup arm. A secondary sheet (or patch) is fed from roll stock and applied to the base sheet by means of a vacuum roll.

As sheets are fed off the top of the stack, it is necessary to elevate the stack to the proper level for sheet pickup. This is accomplished by attaching

This article is based on a paper presented at the "Fifth Conference on Manufacturing Automation" cosponsored by AUTOMATION, Purdue University, and the Manufacturing Engineering Council, April 1961.





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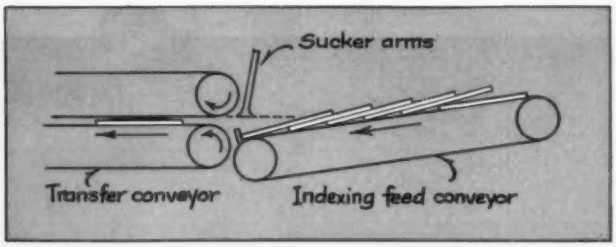


Fig. 3—Photos show loading end and side views of shingled sheet feeder. Unit can be loaded continuously and can handle folded sheet or sheets with tabs that stack unevenly. Diagram illustrates feeding principle employed whereby leading sheet is lifted by sucker arms and introduced between moving belts of transfer conveyor. Feed conveyor indexing is initiated when sucker arms drop low enough for pawl on sucker arm mechanism to engage ratchet on feed conveyor.

a pawl to the sucker arm and a ratchet to the elevator mechanism. When the arm drops low enough, the pawl engages the ratchet and the cam-operated upward travel of the arm indexes the elevator upward by the desired amount.

▶ Overlapped-Sheet Feeders

A "shingled" sheet feeder, *Fig.* 3, permits continuous loading without stopping the machine and permits the feeding of folded sheets or sheets with tabs which stack unevenly and would be impossible to handle on an elevator feeder. Sucker arms lift the leading edge of each sheet into the feed rollers in sequence. In an action similar to that of the elevator feeder, the sucker arm has a pawl which engages a ratchet on the feed conveyor to index it slightly whenever the arm drops to a preset lower position. The conveyor indexes forward gradually to present the proper amount of shingled sheets to the pickup position.

Another type of shingled sheet feeder is shown in *Fig.* 4. This type, called a continuous load friction feeder, is a high speed unit which, to ensure feeding of only one sheet at a time, depends upon adjustment of the clearance between a resilient pad or button on the rotary feed wheel and an adjustable shoe. The air wheel continuous feeder, *Fig.* 5, is a variation of the friction feeder and permits feeding any length of sheet practically edge-to-edge without marring or scuffing the surface of the sheet.

▶ Side-Loading Feeders

The side-loading continuous feeder, *Fig.* 6*a*, is a variation of the elevator feeder, but with the distinction that the sheet being fed is unaffected by any unevenness in the stack resulting from folded or spongy sheets. The stream-fed, side-loading feeder,

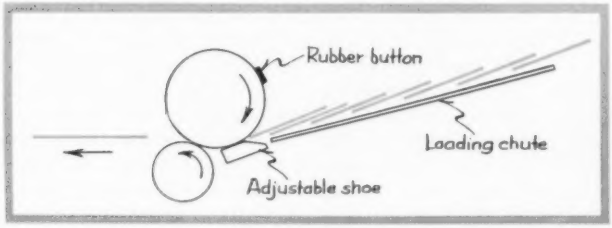
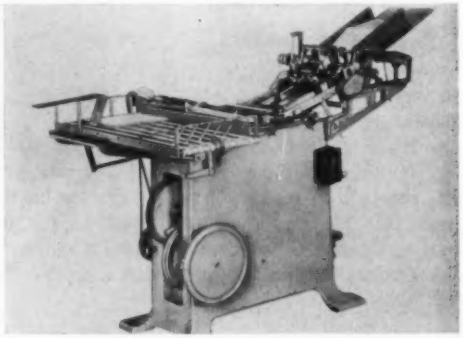
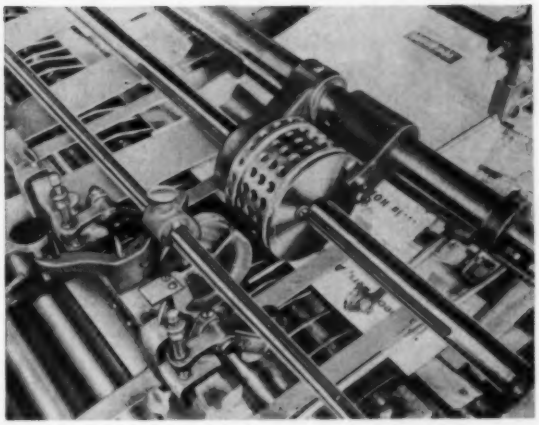


Fig. 4—This high-speed feeder for shingled sheets employs a resilient button or pad on a rotating roller to pick up and advance a single sheet against an adjustable shoe. Sheets are delivered one at a time to an output side with the assistance of a second rotating roller.



Courtesy, B. Verner & Co. Inc.

Fig. 5—Air wheel continuous feeder permits feeding sheets of any length practically edge-to-edge without marring or scuffing the sheet surfaces. Action is similar to that of the friction feeder described in *Fig.* 4.



Courtesy, Dexter Co.,

Fig. 6*b*, is similar except that the sucker arm has been located in a different position to permit sheets to be stream-fed in an underlapped relation necessary to subsequent processing.

The coupon placing machine shown in *Fig.* 6*c* employs an angular side-loading magazine and a sucker arm which removes the leading coupon from the magazine and drops it into a chute. Machine cycling is such that each package presented to the placing machine receives a coupon.

▶ Top-Loading Feeders

Top-loading, bottom-feeding units are not generally affected by unevenness in the sheet stack. These units also permit continuous loading while running. One type, used on a collating device called an arm gatherer, *Fig.* 7, separates the sheets by means of vacuum suckers (and air blasts if necessary). The vacuum suckers pull the edge of each bottom sheet downward. At the same time, pile lifter fingers move forward under the next sheet in the pile, and then upward, to take the weight of the pile off the bottom sheet. A gripper arm then swings forward and pulls the bottom sheet from under the pile. As the gripper arm swings back—carrying the sheet clear of the pile—the grippers open and the sheet is stripped out of the jaws to be dropped onto an indexing conveyor. From the conveyor, the sheet is transferred to the next station. This machine is capable of gathering up to 8400 sets per hour of 48 different sheets per set through the use of 48 feeder stations.

Another type of top-loading collator handles multiple stacks of folded sheets. Called an inserting machine, this unit is used to prepare saddle-stitched magazines, comic books, etc. In operation, a folded sheet from the first feeder station is transferred into the machine with the folded edge leading. The sheet is then reversed and suckers and grippers open the two sides of the sheet. The opened sheet is then deposited over a "saddle," or chain conveyor, that moves the sheet to the next feeder station where a second sheet is added. As the chain conveyor advances, the required number of sheets are collated. The assembly is then stitched by a

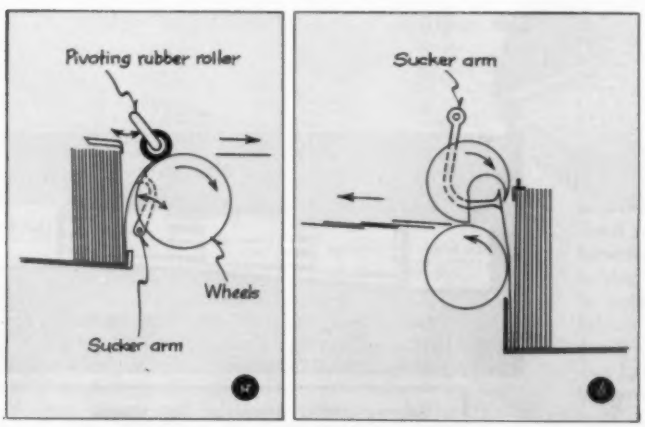
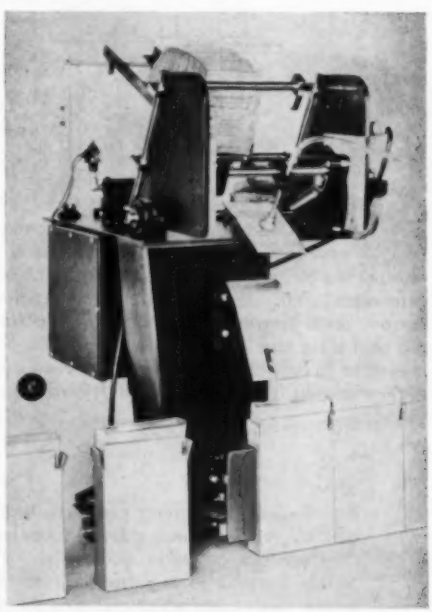


Fig. 6—Side-loading continuous feeder, *(a)*, is a variation of the elevator feeder. Leading sheet in stack is picked up by sucker arm and placed between pivoted roller and rotating wheels. Version diagramed in *(b)* is arranged so as to deliver sheets in underlapped relation. Application of angular side loading mechanism to coupon placing machine is shown in *(c)*. Sucker arm removes a coupon from magazine and drops coupon into a chute. Action is synchronized with motion of packages so that each package receives a coupon.



Courtesy, Thiele Packaging Machinery Co.

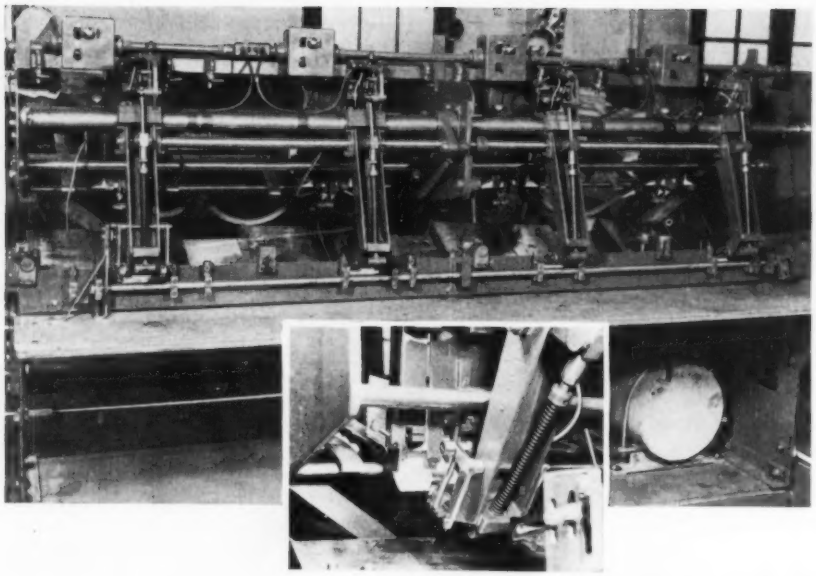


Fig. 7—Top-loading, bottom-feeding devices are used at each of 48 feeder stations of this arm gatherer. Unit can gather, or collate, up to 8400 sets per hour having 48 different sheets per set. Inset shows bottom sheet of stack being pulled outward. Sheet will be released to pan beneath gripper arm. Pan then travels to next station to receive next sheet in preset order.

Courtesy, Dexter Co., subsidiary, Miehle-Goss-Dexter Inc.

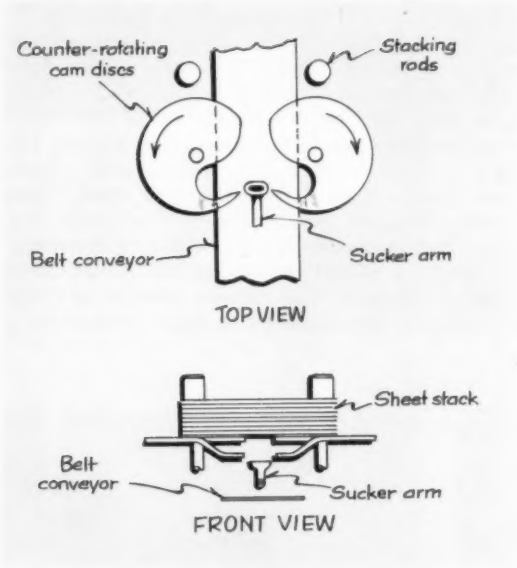
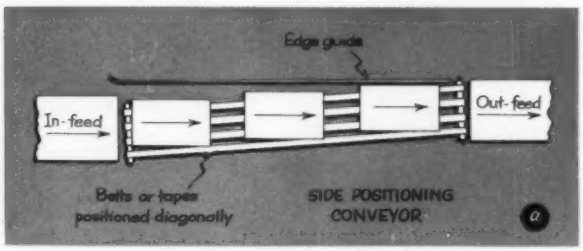


Fig. 8—Envelope blanks can be fed to a belt conveyor in shingled relation by this top-loading continuous feeder. In operation, a stack of envelopes is positioned against a pair of stacking rods by rotation of a pair of cam discs. Vacuum sucker pulls the leading edge of bottom sheet downward so that lower pointed tips of the cam discs can "peel" the blank off the stack. Blank is ejected to belt conveyor. Pitch between edges of successive blanks can be adjusted by varying conveyor speed.

multiple head or gang wire stitcher, and finished products are ejected onto a stacker delivery table.

The top-loading continuous feeder shown in *Fig.* 8 was developed for high speed shingled-relation feeding of envelope blanks. A stack of blanks rests on top of two counter-rotating cam discs. The rotation of the discs keeps the blanks accurately positioned against two stacking rods. In feeding, a vacuum sucker pulls the leading edge of the bottom sheet downward in position to allow the lower pointed tips of the cam discs to peel off the bottom blank and cam it downward. There are also auxiliary arms (not shown) which assist in driving the blank down onto a slow-moving conveyor which runs below and between the two discs. Successive blanks are fed on top of, but slightly behind, the previous ones. This results in a shingled relation of about $\frac{1}{4}$-inch



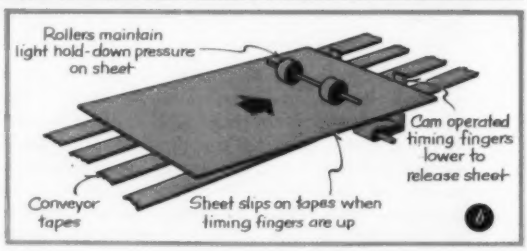

Rollers maintain light hold-down pressure on sheet
Cam operated timing fingers lower to release sheet
Conveyor tapes
Sheet slips on tapes when timing fingers are up
b

Fig. 9—Side-positioning conveyor registers sheets laterally by moving them sideways on belts or tapes until they contact an edge guide, (*a*). Same unit accomplishes lengthwise registration with cam-operated stop finger mechanism which restrains sheet until it is needed in subsequent processing step, (*b*).

pitch between the leading edges of successive blanks. The pitch or spacing can be changed by varying the speed of the conveyor.

In selecting the proper feeder for a given application, the characteristics of the material to be fed—including its ability to slip, its ability to stack, its sensitivity to marring or scuffing, its tendency to generate static electricity, its extensibility, and shape—should be considered. Other factors affecting choice of a feeder include the desired speed and method of delivery to the process.

▸ Conveyors and Positioners

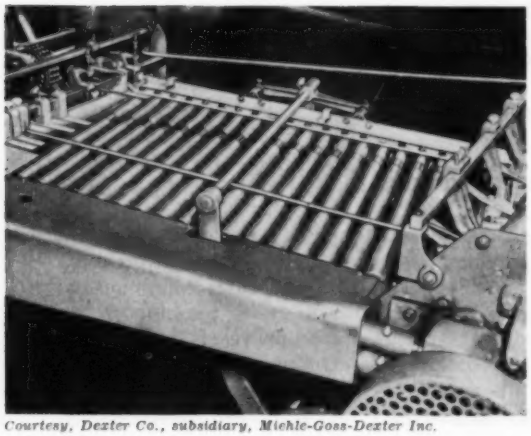
In the foregoing discussion, it will be noted that some feeders accurately position and control the sheet for subsequent operations whereas others merely start the sheet on its way. In the latter case, other devices are required to transfer, accurately register, and synchronize the sheet with other timed processing functions after the sheet has been fed.

A side-positioning conveyor belt, *Fig.* 9*a*, registers or positions a sheet laterally by propelling the sheet diagonally against an edge guide as the sheet progresses downstream. In the same unit, *Fig.* 9*b*, timing registration is accomplished by cam-operated fingers which stop the sheet and allow it to slip on the conveyor belt. Rubber pressure rollers or glass or metal balls maintain pressure against the sheet so that when the stop fingers are retracted the sheet will progress instantly in time with subsequent functions.

The diagonal roller feed table, *Fig.* 10, is similar in function to the diagonal belt device in maintaining side registration of the sheet. The side guide is equipped with a series of glass and metal balls which exert sufficient pressure to cause the sheets to advance at roller speed.

▸ Stream Processing

For certain processes involving individual sheets, it is considerably more convenient and simple to handle the sheets as a continuous stream of material. An excellent example of stream processing is in the application of glue to envelope blanks, *Fig.* 11. By stream-feeding the blanks in an underlapped relation, the glue may be applied continuously to the sheets as if they were a continuous web of paper. Immediately following the application of glue, and



Courtesy, Dexter Co., subsidiary, Miehle-Goss-Dexter Inc.

Fig. 10—Diagonal roller feed table performs side-positioning function to register sheets laterally. Side guide contains a series of metal and glass balls which exert sufficient pressure on sheets to cause them to advance at roller speed.

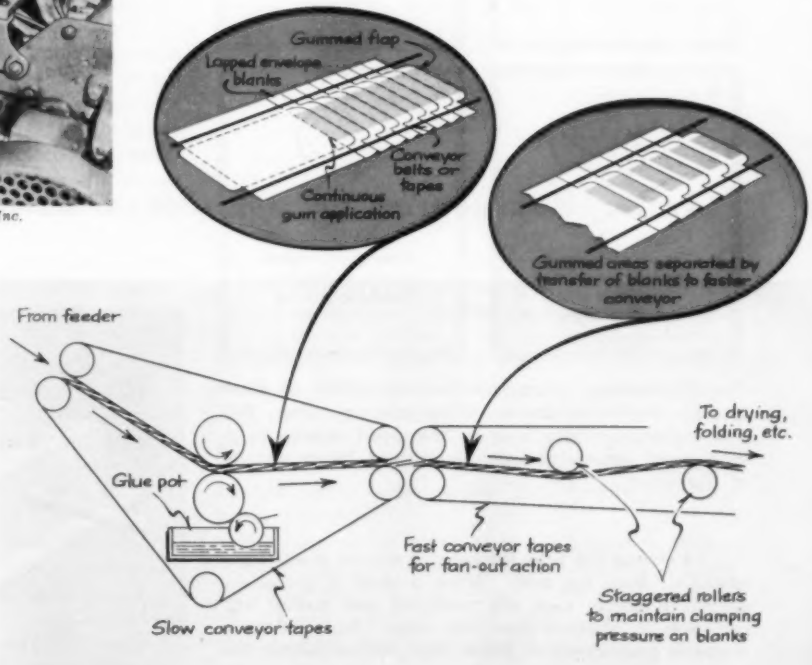

Gummed flap
Lapped envelope blanks
Conveyor belts or tapes
Continuous gum application
Gummed areas separated by transfer of blanks to faster conveyor
From feeder
To drying, folding, etc.
Glue pot
Fast conveyor tapes for fan-out action
Staggered rollers to maintain clamping pressure on blanks
Slow conveyor tapes

Fig. 11—Glue is applied to the flaps of envelope blanks in this continuous stream processing arrangement. Blanks, in underlapped relation, are passed over gluing roll in lefthand section of machine. As they are transferred to righthand section, blanks are separated about 1/16th-inch because of greater speed of tapes in this section. This action prevents sticking of adjacent blanks.

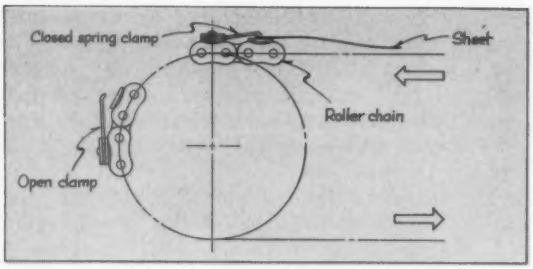


Fig. 12—Roller chain equipped with spring-loaded clamp fingers is useful for handling underlapped sheets. Fingers open and close automatically as chain enters and leaves sprocket.

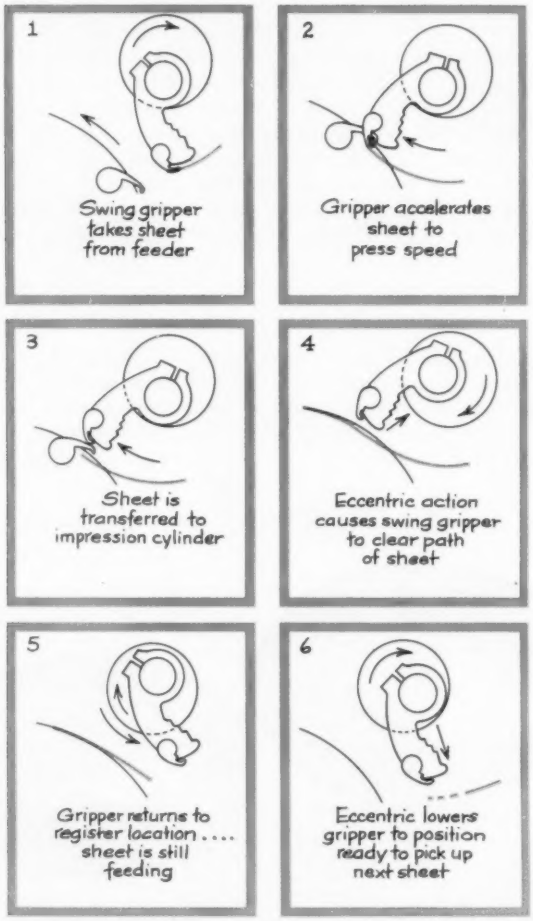

1
Swing gripper takes sheet from feeder
2
Gripper accelerates sheet to press speed
3
Sheet is transferred to impression cylinder
4
Eccentric action causes swing gripper to clear path of sheet
5
Gripper returns to register location .... sheet is still feeding
6
Eccentric lowers gripper to position ready to pick up next sheet

Fig. 13—Series of diagrams illustrates action of sheet transfer mechanism for an offset printing press. Device transfers sheets from a low-speed feeder to a high-speed impression cylinder without losing control of the sheet.

Fig. 14—Magazine type stacker can receive sheets from above or from the side. When a sheet is placed in clearance space, rods are retracted and pusher bar advances to combine sheet into stack. Rods then advance in grooves within pusher bar. When pusher bar is retracted to receive next sheets, rods retain the stack.

before the glue dries, the envelope blanks must be separated to prevent their sticking together. The desired separation is accomplished by transferring the blanks to a second "fan-out" conveyor which is basically the same as the first conveyor except that it is traveling slightly faster. The result is that the pitch relation of the leading edges of the sheets entering this conveyor is increased by approximately 1/16 inch.

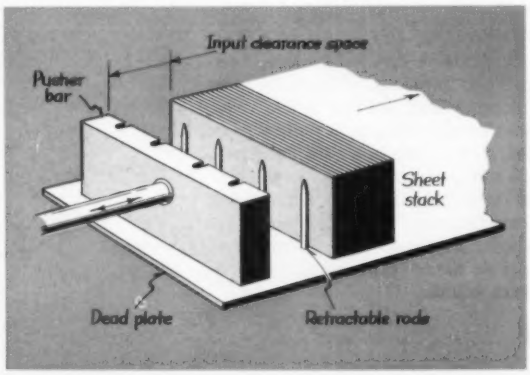
This processing arrangement offers the advantages of continuous gum application to individual sheets with controlled area application but without the use of complicated, synchronized, rapidly cycling mechanisms. The conveyor rollers which guide the belts are staggered slightly to maintain positive clamping pressure on the blanks.

Another type of conveyor for underlapped sheets is a roller chain equipped with spring-loaded clamp fingers, *Fig.* 12. Leaf spring clamps or grippers are permanently attached to the chain links and pitched in relation to the desired spacing of blanks. A unique feature of this device is that it requires no outside actuating mechanism. As the spring grippers move away from the tangent point of the chain with the sprocket, the grippers clamp automatically. As the grippers advance on the tangent point, they unclamp automatically.

Large, high-speed printing presses require hairline accuracy and control of the sheet to ensure good color registration. The series of sketches shown in *Fig.* 13 shows how one press manufacturer handles precise register and positive control of the sheet. The mechanism transfers the sheet from a low-speed feeder to a high-speed impression cylinder without losing control of the sheet.

▶ Sheet Stackers

There are essentially three types of stackers in sheet handling equipment. One type delivers the sheets onto a conveyor belt which is continuously moving or is indexed each cycle, resulting in a shingled arrangement of the delivered sheets. Another type is the pile stacker which delivers the sheets into guides where each sheet settles down on the pile. Some large units have pile hoists which



THE AUTHOR

J. R. HUMPHREY, general manager, Humphrey Design & Mfg. Inc., is well qualified to discuss the subject of handling paper products by virtue of 20 years of experience in packaging, printing, converting, and allied fields. He holds a number of patents in these and other areas including turbine blade contour milling, contour grinding machines, and controlling viscosimeters. He founded Humphrey Design Co. (now Humphrey Design & Mfg. Inc.) in 1950. The firm specializes in packaging, converting, and stapling machinery. Mr. Humphrey received formal training at Purdue University.

function in reverse to the action of a pile feeder. On high-speed presses or sheeters it is necessary to slow down the fast moving sheets before they reach the pile. One technique used to slow down the sheets is to pass them over spaced, perforated suction wheels prior to dropping the sheets onto a stack.

The magazine or side-stacking delivery type stacker, *Fig.* 14, is used in packaging and bookbinding machinery as well as for handling paper sheets. The product is either dropped into the unit from above or fed in from the side. The rods retract and the pusher transfers the new piece against the stack. The rods then advance within grooves provided in the pusher, the pusher retracts to receive the next piece, and the previous piece is trapped behind the rods with the previously accumulated stack.

▶ Conclusion

This article is intended to familiarize those in other fields with some of the equipment that has been devised for the automated handling of paper products during processing. Many other unique machines (and mechanisms within such machines) have been developed in the industry. For example, an interesting operation is that of folding sheets in a folding machine, *Fig.* 15. As shown in the diagram, a sheet is fed between rolls. As the leading edge of the sheet contacts a stop, further in-feeding causes the sheet to loop or bend downward. This loop is picked up by rolls and compressed, and a folded sheet is ejected from the device. Study of such principles can lead to solutions of automatic handling problems in other areas.

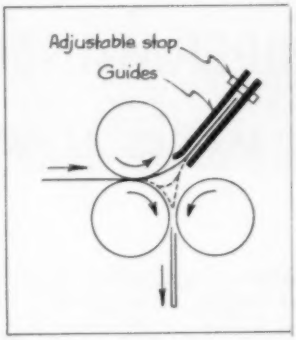


Fig. 15 — Folding machine feeds horizontal sheets by means of rolls. When leading edge of a sheet contacts an adjustable stop, continued feeding causes sheet to bend downward and be picked up by rolls for folding and delivery to subsequent operation.

production bottleneck avoided with numerical control

FLEXIBILITY in programming a numerically controlled machine tool was a decided advantage for Aeronca Mfg. Corp. when a recent design change required a shift from aluminum to steel in the production of hinges for a military aircraft. The hinges, which support lift spoilers, were being made on a Cincinnati Milling Machine Co. numerically controlled Hydrotel machine. In two designs, and left and righthand configurations, the parts have thin webs, multiple angles, and pockets with sloping bottoms.

The problem faced by Aeronca was to maintain interim production of parts from blocks of 4340 steel until dies could be provided to produce them as 4140 steel forgings. If the job had been set up for tracer control, two master parts would have been required, and the constant attention of an operator would have been needed during machining.

The solution adopted was to devise two numerical control programs so that the steel parts could be machined on the Hydrotel. Programming required approximately 80 hours, and resulted in the development of 1800 punch cards for the two part types. The cards are arranged in two decks for roughing cuts and two decks for finishing cuts. The same cards are used for either hinge side, since the numerical control circuits can make the necessary mirror-image conversion.

With the rough parts in an eight-position fixture, it takes 3 hours of machine time to mill each hinge, including three cutter changes. With a proposed changeover from high speed steel to carbide cutters, this machine time is expected to drop to 1 hour per part.

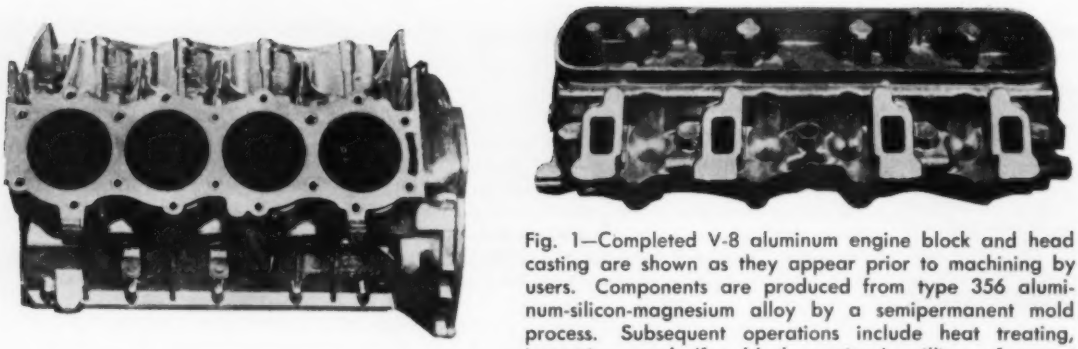


Fig. 1—Completed V-8 aluminum engine block and head casting are shown as they appear prior to machining by users. Components are produced from type 356 aluminum-silicon-magnesium alloy by a semipermanent mold process. Subsequent operations include heat treating, inspection, and (for block castings) milling of target check points.

SEMIPERMANENT MOLD PROCESS

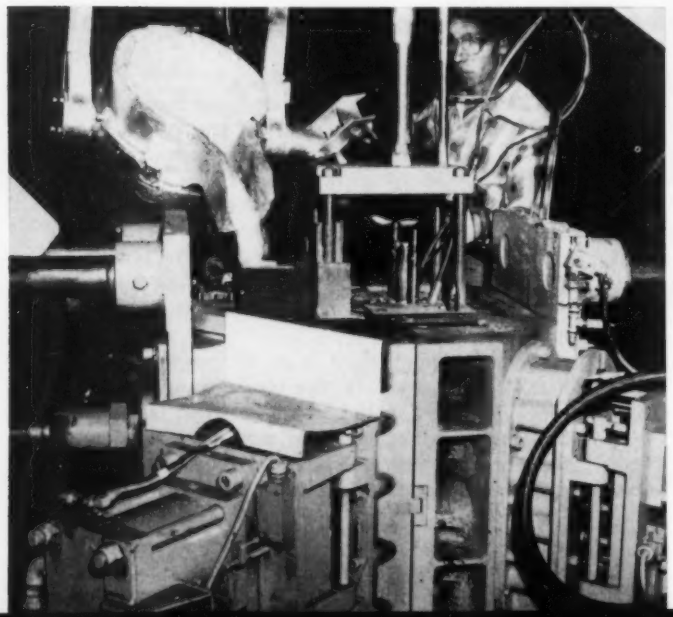
MAKES ALUMINUM ENGINE CASTINGS

WHEN General Motors Corp. decided to manufacture new, lightweight, water cooled V-8 engines for several models of its automobiles, mass production methods had to be developed for casting the aluminum cylinder blocks and heads, *Fig.* 1. Since the block and head designs adopted could not feasibly be cast by either the sand or existing die casting processes, the Central Foundry Div. of GMC decided to use the semipermanent molding process for the production of both types of parts at its Defiance, Ohio plant.

Processing begins when new metal, clean scrap, and chip metal are melted in four gas-fired reverberatory furnaces. The molten metal is fluxed and cleaned in the furnace and samples are taken for chemical analysis by direct reading quantometer. The molten aluminum is then tapped directly into delivery ladles and transported by special truck to gas-fired holding pots on molding platforms. Gas density is checked and controlled in the holding pots.

Coremaking

Six sand cores are required to produce a cylinder block casting. Four of the cores form the crankcase



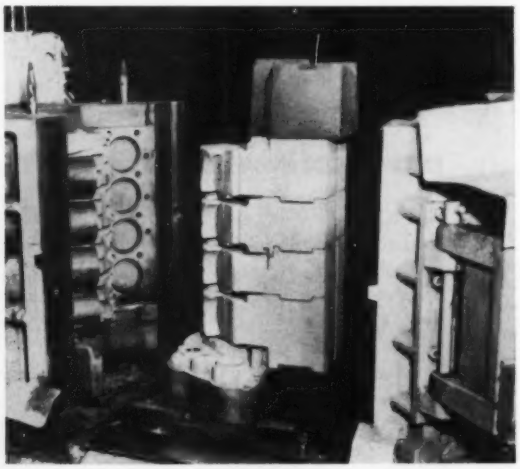


Fig. 2—With dies hydraulically closed, operator pours molten aluminum alloy into mold for block casting. Inset shows stack of four urea sand cores for crankcase, topped by core that forms pouring box, positioned above lower section of mold, center. Steel cylinder liner inserts are visible in lefthand die section.

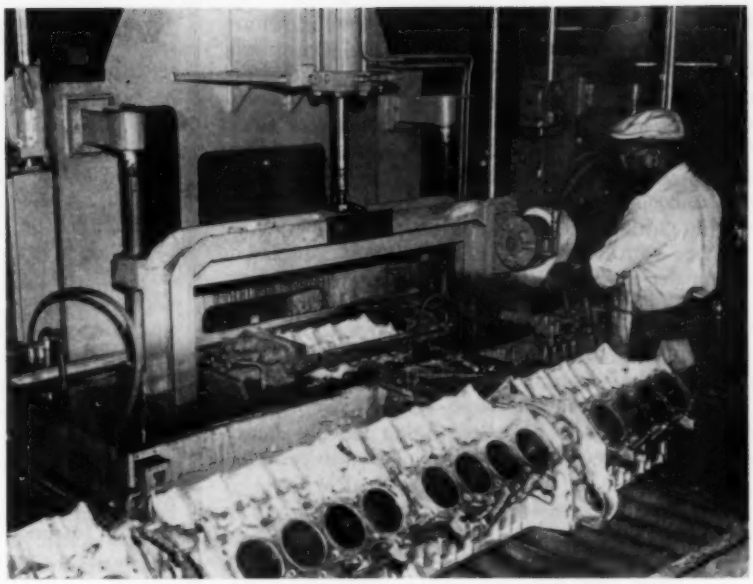


Fig. 3—Block castings from which flash and risers have been machined are submerged in water and pressure tested with compressed air at this station. Similar equipment is provided for pressure testing of head castings. After dimensional checking, head castings are ready for shipment. Block castings undergo additional machining and inspection operations before they are shipped.

area and the other two cores form the water jackets. Sand cores are also used to form the water jacket, header, and intake and exhaust ports of each cylinder head.

The most important properties that cores must have for use in aluminum casting are good collapsibility to permit easy removal after casting and low gas evolution during the casting process. To meet these requirements, a special urea sand mixture was developed for aluminum coring. Such cores can be made with conventional core mixing and blowing equipment and then baked in conventional core ovens.

At the plant, core sand is mixed with urea formaldehyde, clay, and water in a muller and discharged to a belt conveyor system that transfers it to a silo. Sand taken from the silo is transferred to core blowing machine hoppers by motor-driven wheelbarrows. Conventional semiautomatic core blowing machines are used to form the cores, which are automatically stripped onto driers and baked in vertical core ovens. Baking time is dependent upon the core cross-sectional area. After baking, the cores are processed, gaged, and placed on racks for delivery to the aluminum molding area.

Molding

All aluminum molding operations are performed on raised platforms with belt conveyors under the platforms to remove the castings. A continuous conveyor carries cores to all molding stations.

The aluminum castings are produced in special semipermanent mold machines, *Fig.* 2. These machines are hydraulically operated and use water-cooled metal molds in conjunction with the disposable urea sand cores. Features of the equipment include pouring of the block casting in a vertical position rather than the horizontal position used in casting gray iron blocks, and temperature control of metal permanent molds. All sections of the molds are water-cooled, with thermocouples relaying temperature information to a master recorder on a control panel.

Elaborate gages have been developed to check mold alignment and core locations in the hot and cold states during initial setup and operation. The sand cores are gaged in the molds to ensure proper location, and vents have been provided to allow core gas escape.

Precast gray iron cylinder liners are heated and located on retractable mandrels in the molds to facilitate handling and proper location. The liners are grooved on their outer diameters to increase the bond between the aluminum and iron.

After cores and liners have been placed, the mold is hydraulically closed. Molten metal is then ladled from the holding pot and poured into the mold. Following a brief solidification period, the mold opens and the casting is removed with an overhead hoist. It is then lowered onto a belt conveyor through an opening in the raised molding platform.

Block castings are subsequently transferred to a cooling conveyor where they cool for a two-hour period. They then proceed to finishing operations. Cylinder head castings are made in much the same manner except that they are cast in a horizontal position in semipermanent mold machines.

Finishing

When they are cool, block castings are vibrated to loosen and remove the core sand. They are next transferred to a special definning machine, de-

signed and built at the Defiance plant, which automatically breaks off the sprue and removes flash from the cylinder bores, water openings, and main oil galley. The crankcase areas of the blocks are then shot-blasted to remove any residual core sand. Core sand is removed from the head castings on special shakeout machines. Conventional iron casting shakeouts are not satisfactory due to their tendency to mutilate the soft aluminum.

Next, both block and head castings are placed in transfer machines. The heads are milled on their manifold faces and cover rails to remove flash and risers. Blocks are machined to remove flash from the pan rails, front faces, camshaft bearing holes, and crankshaft bearings.

Castings then pass through a final cleaning operation and are heat treated. Aging for five hours at 400 F relieves stresses and stabilizes the castings.

Inspection

All block and head castings are submerged in water and pressure tested with compressed air, *Fig.* 3. Following this operation, they are gaged for dimensions. At this point, cylinder head castings are ready for shipment to the customer's motor plant. Block castings undergo further machining and dimensional inspection.

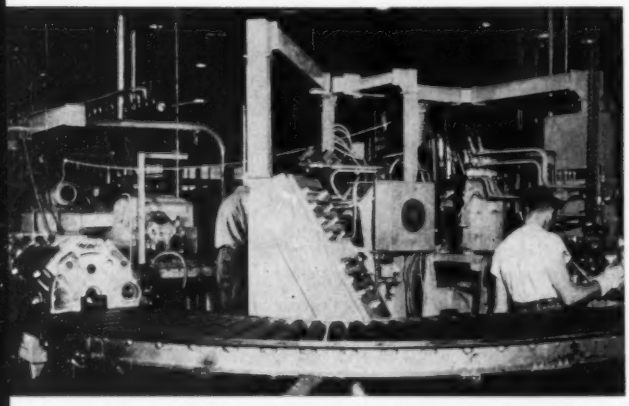


Fig. 4—Block castings are machined to remove excess metal and to provide qualifying pads, left background. They are then processed through special machine, foreground, that automatically checks dimensions from 22 target points.

In these operations, *Fig.* 4, block castings move into a specially designed automatic qualifying machine which locates and mills end and side targets in relation to the cylinder bores. A final dimensional check is made on a special air-electronic gaging machine which locates on the milled targets and checks the location and surface finish of 22 separate areas including all eight cylinder bores. Block castings are then ready for shipment to the customer.

MAINTENANCE OF COMPUTER SYSTEMS

By THOMAS R. DARMODY
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COMPUTER SYSTEMS cannot and will not do a job unless they are properly and efficiently maintained. Whether homegrown, bought from the builder, or contracted from a specialist, the maintenance program must be considered well before a computer is installed and should be set up and working the day the system begins operating. The cost of inoperative time on a computer system is far greater than the cost of sensible maintenance.

Electronic systems cannot be made to work all the time unless the equipment has been designed at a redundancy level of 100 per cent or better. Most computers are not so designed and must be partially or completely shut down during maintenance. Realistic plans for operating and maintaining such equipment must therefore provide for nonoperating maintenance periods.

Early vacuum-tube computer systems were built with an operating availability of about 80 per cent. This figure represented the predictable "good time" that could be used by the programmer. Fifteen per cent of the total time had to be devoted to preventive maintenance, and—if efficient maintenance was applied—the remaining five per cent covered downtime due to unpredicted failure and required corrective maintenance. These figures were based on a system used 168 hours per week. For a system operating only 8 hours per day the availability figure could be expected to stay pretty close to 95 per cent or better, since preventive maintenance could be performed in off hours.

Since the development of computers using transistors and magnetic amplifiers, the use figure has improved substantially. This is due partly to the more reliable components and circuits, partly to new maintenance aids and fault alarms which are being built into newer systems, and partly to the fact that new design techniques permit pulling out a faulty circuit and replacing it with a good one, instead of repairing the one in the machine with pliers and soldering iron.

Procedures and Schedules

Maintenance procedures for a digital computer system are customarily set up with interlocking and complementary schedules on daily, weekly, monthly, and quarterly bases. Daily maintenance must preempt half an hour or an hour of the computer's time. It frequently consists of no more than a careful inspection of the turn-on and start procedures,

with perhaps the running of a checkout routine.

Working in conjunction with daily maintenance is the record of intermittent faults noted during operating hours but not requiring immediate correction. The maintenance technician uses this report to focus attention during the maintenance time, and can frequently find the source of such faults during the scheduled off-time. His own record of corrective maintenance performed during the preceding shift or shifts also serves him as a guide.

The weekly maintenance period probes more deeply into the operation of the system. In some cases, this weekly procedure is merely a more comprehensive version of the usual daily checkout; in other cases, it covers a complete shift. It is not unusual to break up the sequence of annual, semiannual or quarterly maintenance procedures so that one or more of the smaller jobs is performed during each weekly period.

Monthly, quarterly, semiannual, or annual schedules are customarily devoted to overhaul of subsystems, installation of manufacturer modification and change orders, and major maintenance procedures. Such procedures may involve cleaning the entire system, lubricating mechanical parts, and scheduled replacement of those parts whose lifetimes have run out.

Maintenance Routines

Maintenance for an electronic computer system involves tests of circuit operation in terms of the logical results. Typical among the maintenance procedures are sequence checks, logical checks (which are embodied in a computer program) and operational routines which explore the functioning of whole subsystems of the computer.

Just turning on an electronic computer, or any complex electronic system, tells the operator a great deal about its functioning. Careful inspection of panel lights and meters discloses many types of faults during this procedure.

Built into most electronic computers are numbers of checking circuits for detecting dropped pulses or illogical groupings of either pulses or control signals. Counters placed in the path of information transfer can total up each digit's or word's pulse count, and if it is not par can signal an error. Such parity checkers are the most common type of error detector used in computer systems.

A powerful maintenance aid is the so-called omnibus routine. This is a computer program that uses every portion of the system's circuits, usually in the most demanding possible routines, and relies on built-in parity checks and final answers which are known in advance to determine whether or not any circuit or subsystem is malfunctioning. Omnibus routines are a part of the weekly maintenance of almost all large computer systems, and simplified versions of them are frequently used in the daily checkout.

Another aid frequently found in modern computers is the marginal test. Many electronic components age by losing their capacity to carry current. Reducing the voltages applied to them simulates this "aged" condition, and can be used to force failures during maintenance periods. In the marginal check operation, an omnibus routine is run while the voltages are reduced to the marginal level, and any malfunction occurring during the run is corrected.

Personnel, Tools, and Supplies

A computer's time is worth hundreds of dollars an hour, and waiting for a maintenance engineer or technician is costly business. Engineers or technicians capable of performing analysis, trouble location, and corrective measures should always be standing by or within easy call. Such standby personnel do not necessarily become wasted overhead. Invariably there are portions of any large system which are not in use and which can be scheduled for routine maintenance or overhaul during normal duty hours, while the engineer or technician is standing by in case of a central emergency.

Analysis of trouble generally involves running an omnibus routine or trouble-locator program. The latter programs set up a problem or logical sequence which goes through the system one subsystem at a time. When the program reaches the subsystem in which the error occurs, the computer check circuits automatically halt the operation with the trouble indication showing. Once the offending subsystem or circuit is located, conventional corrective techniques are used to fix it. In today's computer systems, it is frequently possible to unplug the entire circuit or subsystem and plug in a substitute. The faulty equipment is then repaired at the workbench while the computer goes on working.

Only experience can guide the maintenance chief on the amounts of components and replacement circuits to hold in stock. Fortunately, the experience of users of particular systems is generally made available to other buyers of the same type of system. The fact that most computers are designed to use large populations of only a few kinds of standardized component also reduces the supply problem.

Of critical importance to the maintenance technician is efficient test equipment. Precision oscilloscopes, voltmeters capable of measuring values in pulse circuits, tubecheckers that can simulate pulse conditions, and other maintenance tools required in maintaining a computer are quite costly, but the expense is small when measured against its alternative, increased downtime. The cost of an hour spent fruitlessly looking for a transient fault with an ordinary oscilloscope would put a healthy down payment on a precision high-speed instrument.

Communications with the purchasing department can become critical in cases where supplies of a needed component are exhausted. At such times, the maintenance chief requires—and in most installations today, already possesses—the authority to purchase parts and specify delivery method on his own decision, in order to clear the track to get the computer back "on the air."

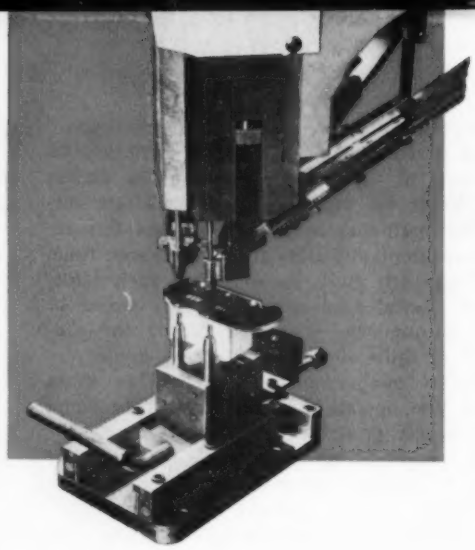

Fig. 1—One method of designing safety into a riveting fixture is to keep both hands of an operator busy. In this fixture, the combination of a manual slide fixture to be moved by the right hand and a palm switch to be pressed by the left hand does not allow the operator a free hand to move under the riveting head. The parts to be riveted are placed on the two roll set plunger pins in an anvil block while the two-position slide is in the *Out* position. As the operator's right hand moves the slide forward to the *In* position, a limit switch is closed by the slide. The riveting operation can begin only when the palm button is pressed at the same time that the slide switch is closed.

FIXTURING FOR RIVETING

By T. C. BUCHANAN
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Riveting can be a high speed assembly method since rivets may be fed automatically to one or more heads cycling at rates over 230 strokes per minute. However, to attain maximum production, workpieces must be fed and positioned under the rivet-setting heads as expeditiously as possible. A general knowledge of the many types of work holding fixtures is paramount in maintaining a smooth flow of parts to the fast-cycling heads.

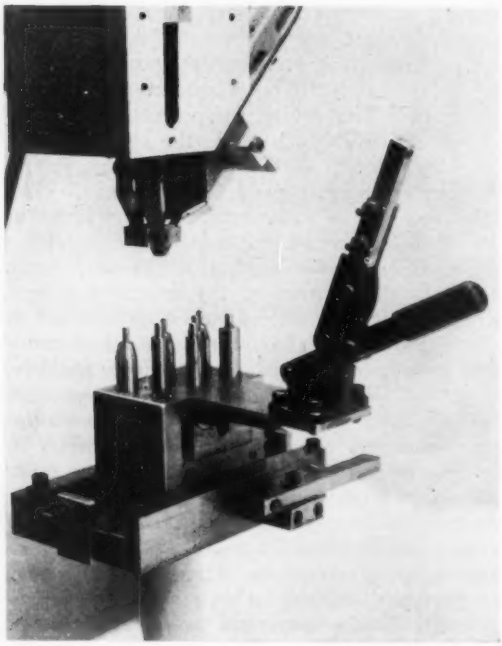


Fig. 2—In a fixture for riveting a mounting bracket of a voltage regulator, the parts are positioned for riveting at three points by a three-position slide fixture. The parts are located on the roll-set holder by four mounting pins and are held down by a toggle clamp. The roll-set holder is moved against positive stops at both ends of the fixture for setting two outside rivets and is located by a detent button for setting a middle rivet.

CONTINUING development of improved rivet-setting machines has made it possible to produce superior fastened joints at increasingly higher production speeds. The capacity to eliminate many or all manual steps before and after riveting and to adjust the riveting cycle to match the flow requirements of associated equipment is particularly important in planning automatic production. The performance of rivet-setting machines in large-volume manufacture depends very much on how well the riveting fixture has been designed to prepare the parts for the riveting action itself. Too often, even though both the rivets and machine are right for the job, a rivet-setting operation gets off on the wrong foot or never really reaches its potential output rate because a fixture is poorly designed.

A riveting fixture may be quite simple or may be extremely complicated. It may vary in complexity from a specially shaped roll set on a single-spindle rivet-setting machine to an elaborate work-transfer table serving a multiple machine automatic system. Whatever the fixture arrangement, inserting and upsetting the rivet itself is a function of the machine, while the fixture simply carries and holds the parts to be riveted.

Necessity for Fixtures

There are three specific reasons for using riveting fixtures: 1. To improve safety. 2. To increase productivity. 3. To overcome adverse design characteristics.

Improve safety. As with many other types of production machines, operators are often tempted to install and remove parts by hand from under the driver and jaws of the riveting head. In many riveting operations, it is inherently impossible to handle the parts dangerously in placing them in a riveting position. In other operations, it is necessary to provide some way to eliminate a potentially dangerous operation. Palm switches, mechanical work area guards, and photoelectric cells are common safety devices. A typical fixture designed primarily in the interests of safety is shown in *Fig.* 1.

Increase productivity. A higher assembly rate means lower unit labor cost as well as higher machine productivity. Fixtures can permit quicker loading of parts that must be positioned in a particular relation, can substitute mechanical action for manual action, and can simplify motion.

Productivity can be increased by speeding up the

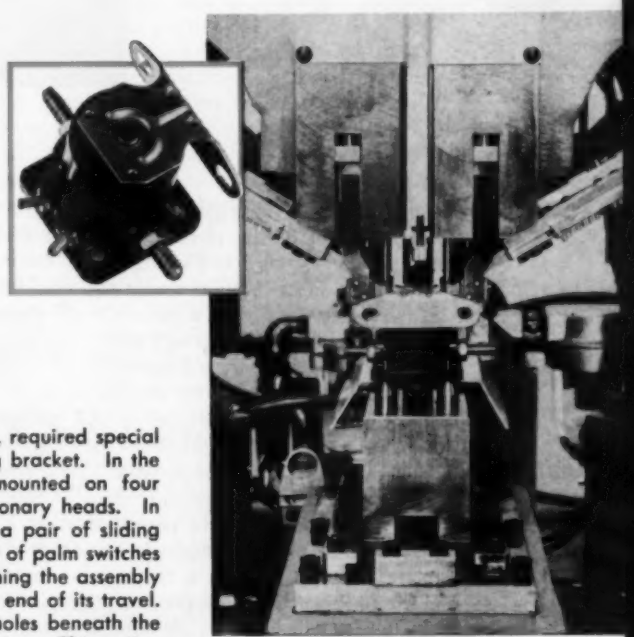
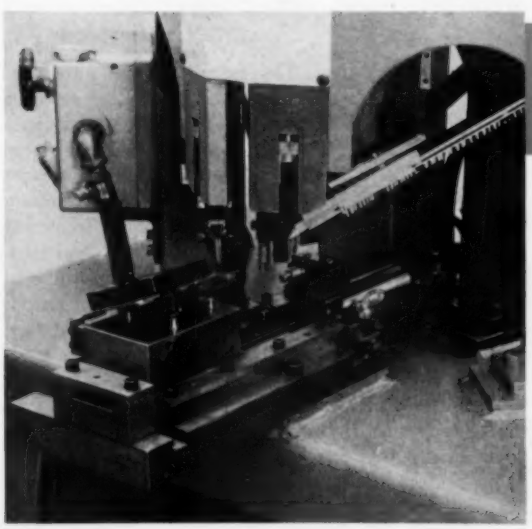


Fig. 3—Fixture for riveting a starter solenoid assembly, inset, required special consideration since two of the rivets were under a mounting bracket. In the fixture, the bottom plate and the solenoid body were mounted on four plunger pins. Two of the rivets were set normally by stationary heads. In the case of the two rivets beneath the mounting bracket, a pair of sliding heads were used. In operation, an operator actuates a pair of palm switches which cause a pneumatically powered roll-set holder containing the assembly to move into the riveting area and trip a limit switch at the end of its travel. Two pneumatic sliding heads then move forward over the holes beneath the mounting bracket and actuate a limit switch when in position. This action starts the riveting cycle for all four heads, and four rivets are set simultaneously. After setting, the sliding heads retract, and the roll set holder moves the riveted starter solenoid out of the riveting area and to the operator.



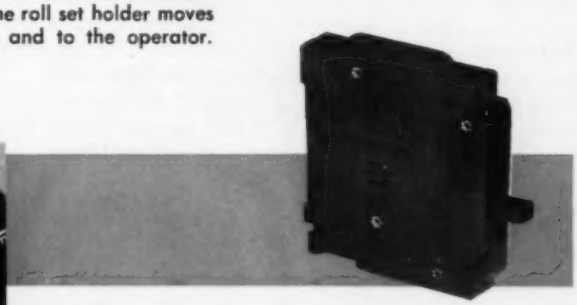


Fig. 4—The parts of a circuit breaker housing are placed over four roll sets in this pneumatically operated slide fixture. Upon activation by a foot pedal, the pneumatic cylinder pulls the slide fixture under a safety shield (not shown) and into the riveting area. As the roll-set holder reaches the end of the slide, a limit switch is closed, starting the riveting cycle. After riveting, the pneumatic cylinder returns the fixture to the loading position. An ejection plate over the roll-set holder is hinged on the lefthand side. As the fixture returns to the loading position, a pin in the holder strikes the lower surface of the ejection plate, causing it to lift and dump the part off the fixture. A riveted circuit breaker is shown in the inset.

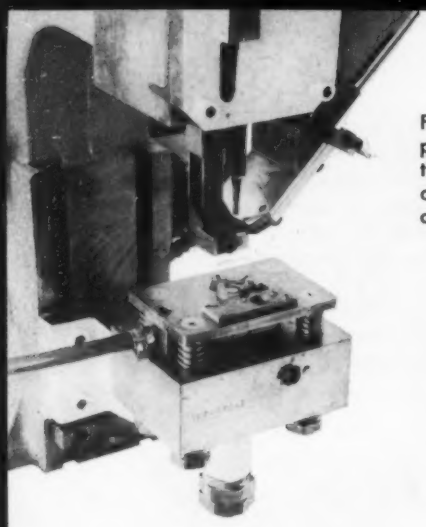
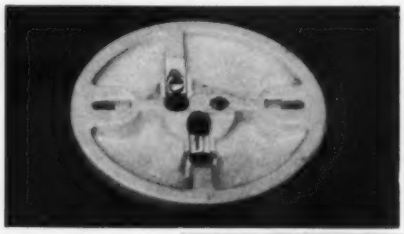


Fig. 5—A part can be located in a fixture by its shape. In this case, two small parts of a circuit breaker are nested in proper position for riveting by matching the shape of the fixture to the shape of the outside edges of the part. Because of the type of fastener required by the assembly, exact positioning has been accomplished without guidance by a plunger pin in the roll set.



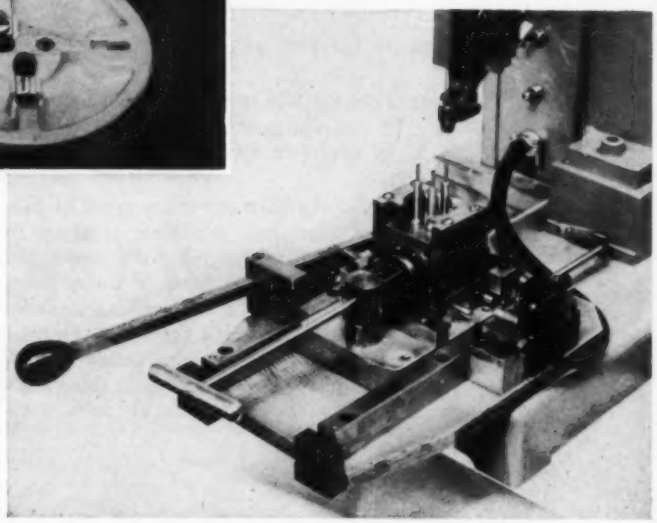


Fig. 6—A part can be located in a fixture by a combination of pins and a finger. This riveting fixture enables a single-head machine to set three rivets in fastening two terminal pieces, a center contact, and a socket lining to a ceramic light socket, inset. As shown by the position of the porcelain body, the socket lining and the center contact are first placed on the fixture; then the porcelain part and the two terminal pieces are located. An upright metal finger between the three roll sets locates the center contact in the socket base. The porcelain part, socket lining, and terminal pieces are aligned properly by the three plunger pins. In this case the molded shape of the porcelain part also helps to locate the terminal pieces.

functions of positioning (bringing parts to and from the working position in the riveting machine) and of locating (nesting parts for riveting either before or after they have been brought under the machine head). For example, in *Fig.* 1 a generator-oil pressure indicator assembly is positioned under a triple-head rivet-setting machine by a hand-operated slide fixture. Another example is shown in *Fig.* 2. In this case three rivets for a mounting bracket of a voltage regulator are both positioned and located by a fixture.

Overcome adverse design characteristics. The shape, size, dimensional accuracy, or orientation of a component may require a fixture to permit riveting in an automatic machine. For example, in the assembly of the starter solenoid, *Fig.* 3, a rectangular metal plate had to be riveted to one end of the plastic solenoid body. In a previous operation a stamped metal mounting bracket had already been placed on the other end of the solenoid. Interference by the mounting bracket and the height of the solenoid body presented serious problems in affixing the bottom plate to the solenoid with four rivets. The problems presented by the difficult shape of the solenoid were overcome in the design of the riveting fixture and by using a pair of sliding rivet-setting heads.

▶ Types of Fixtures

There are many types, variations, and combinations of fixtures. The riveting specialists at major machine manufacturers can suggest one or more practical methods for solving a particular fixture problem. In handling the detailed design of the fixture itself, the production engineer—who is responsible for methods of machine riveting and who must consider safety, productivity, and product design—may benefit by understanding the various types of riveting fixtures that are commonly used and how they may be combined in specific riveting operations. A number of examples of fixtures in actual riveting jobs are explained to show how fundamental fixturing ideas can be adapted to special fixturing conditions.

Positioning fixtures. Depending on the nature of the riveting operation, a positioning fixture may be any one of a variety of manual or powered devices, but in all cases it is designed to bring the parts to be joined into and out of the working area under the riveting head. The simplest type of positioning fixture consists of a roll set holder which is moved in a channel between the load and work positions. Such a device, normally called a slide fixture, can be designed so that it can provide varying length of travel between the two positions, can hold any number of roll sets, and can be used with more than one rivet-setting machine. The slide fixture shown in *Fig.* 2 was slightly more complicated in that there were three riveting positions, and a hold-down clamp was provided. Although safety is a frequent reason for its use, the usual purpose of a slide fixture is to speed up the riveting operation by mak-

ing it easier for the operator to locate components to be riveted over the roll set plungers. Of course, all fixture elements that are needed at the riveting position, such as a leveling table, may be mounted on the roll set holder.

Pneumatic power may be provided for positioning of slide fixtures to make the operation safer by eliminating hand positioning under the riveting head, to speed up the riveting cycle by permitting simultaneous manual and pneumatic parts handling, and to provide sufficient power to move heavy or bulky parts and thus minimize fatigue. For example, in *Fig.* 4 a slide is powered by a pneumatic cylinder activated by a foot pedal in order to provide time for an operator to pick up parts required for the next riveting cycle. The slide fixture also ejects the completed riveted component after the roll set holder has returned to the load position. Another ejection method that can be used is an air jet blowing from under the table and up and around the anvil.

Locating fixtures. Manual alignment of parts for riveting can be tedious and expensive, requiring a far greater proportion of the assembly time than the actual rivet-setting. Therefore, it is economically desirable to specify a nesting fixture that will either cut down or eliminate locating the parts by hand. The simplest and most common locating fixture is the roll-set plunger pin itself, which can line up two holes but cannot alone ensure that the parts are properly oriented about the holes. The parts can be aligned in the same relative location for each riveting cycle only when either two or more plunger pins are used as in multiple riveting or when a nesting means is provided in the fixture.

Referring back to *Fig.* 4, a tooling problem in fastening the two molded plastic halves of the casing for the circuit breaker required that star set clinches be formed on four one-piece anvils. Because there were no plunger pins to align the bottom half of the anvils, some other means of locating the part had to be used. Therefore, the diameters of the anvil noses were specified so that they fitted exactly into the molded counterbores in the bottom half of the casing. Since the top half mates into the bottom half, the operator had only to place the bottom half over the four anvil noses, put the top half in place, and the parts were precisely aligned for the rivet-setting operation.

Representative examples of other frequently used locating fixtures are shown in *Fig.* 5, 6, 7, 8. In most cases all of the fixtures described are relatively simple in design and yet perform a function that would otherwise have to be done manually.

▸ Rotary Tables

Like a slide fixture, the function of a rotary table is to bring the pieces to be joined into and out of

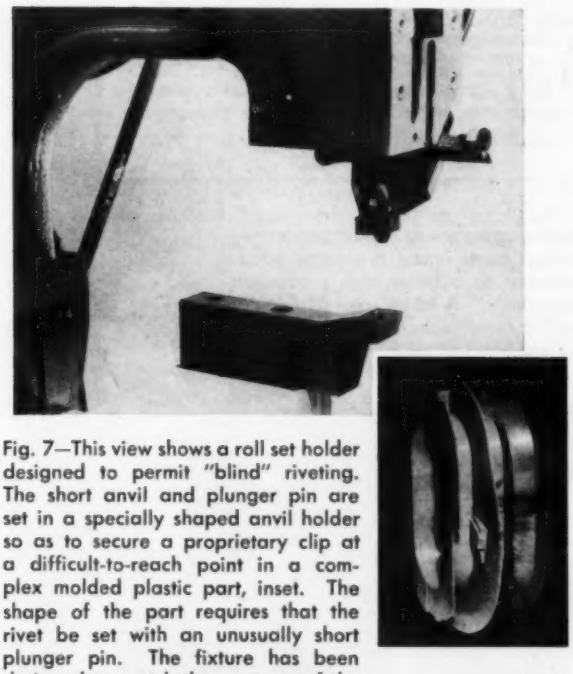


Fig. 7—This view shows a roll set holder designed to permit "blind" riveting. The short anvil and plunger pin are set in a specially shaped anvil holder so as to secure a proprietary clip at a difficult-to-reach point in a complex molded plastic part, inset. The shape of the part requires that the rivet be set with an unusually short plunger pin. The fixture has been designed to match the contours of the part so that after the clip has been placed on the plunger pin, the operator can orient the part by touch, without having to see the rivet area.

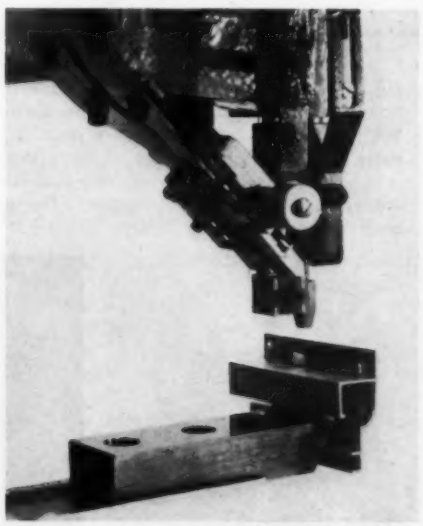


Fig. 8—Fastening a spring clip to an aluminum storm window frame presented an even more difficult problem in blind riveting. Since the restricted space in the frame channel did not allow any plunger pin, the piece has to be located over a solid roll-set insert, both by eye and by the shape of the roll-set holder. The channel is placed over the roll-set holder and pushed against the holder's outside surface and along its length until the roll set is visible in the hole. Since the machine is foot powered, both of the operator's hands are free to locate the channel and clip.

BASIC RIVETING

TERMINOLOGY

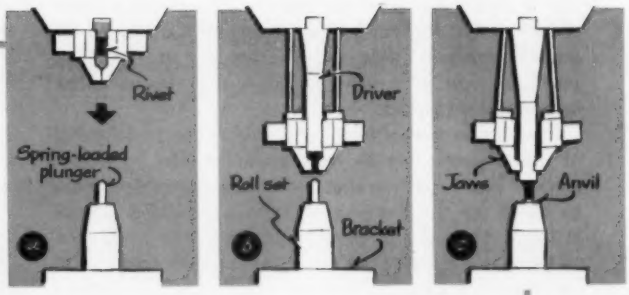
RIVETING is one of the oldest methods of assembly, yet today its popularity is greater than ever before. In the automotive, appliance, electronic, furniture, hardware, military, and business machine fields, the use of rivets and riveting has been constantly expanding both for job shop and production line operations.

While there are endless variations of anvil designs, there are only three basic clinches for tubular and split rivets. These clinches are the roll set where maximum strength is required and wall thickness is not excessive; the star set for deep drilled or full tubular rivets, or for use when there are thickness variations that must be compensated for in the assembly; and the prong set which is the form taken by bifurcated or split rivets. These clinches are formed when a rivet is driven down against an anvil by a driver in a rivet-setting machine head.

Driver. The driver is located in the ram or spindle of the machine. The working end of the driver is formed to the contour of the rivet head. The straight portion of the driver is held to the predetermined diameter for a length somewhat less than the length of the jaw. Above this point the driver is shaped according to the design of the tool.

Jaws. The jaws are fastened to a sliding member mounted adjacent to the driver. They are usually supported by a pair of flat springs to allow the rivet and driver to pass through the jaw halves. A rivet is fed to the jaws by an automatic hopper and raceway, which deposits a rivet in the jaws at the start of each riveting cycle. As the cycle continues, the driver descends and lowers the jaws to a stop. The driver continues the descent, pushing the rivet through the two halves of the jaw onto a plunger pin in a roll set.

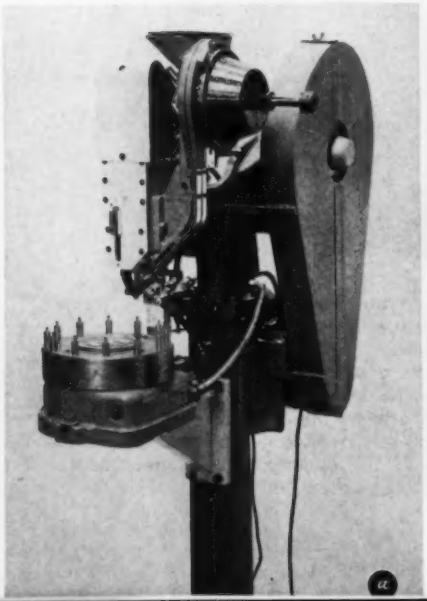
Roll sets. Roll sets usually consist of four components: Plunger, anvil, nut, and spring. These parts have a definite relationship to each other and to the rivet. For standard applications, plunger protrusion is equivalent to the length of the rivet. However, where the assembly is sprung or to be compressed, longer plungers are required. The purpose of the plunger is to pick up and help center the rivet correctly in the work. Plunger diameters are normally a few thousandths larger than the rivet shank diameter. This condition allows the roll of the rivet to start on the plunger form. As the driver continues downward, the plunger pin retracts against spring pressure and guides the rivet through the workpiece until it bottoms against an anvil and is clinched. When the driver and jaws retract, the plunger pushes the rivet and workpiece off the roll set.

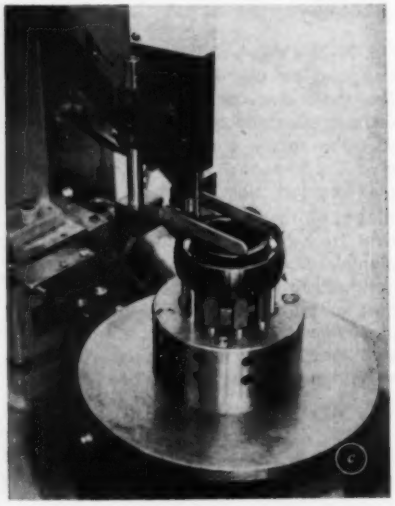


The anvils which form the clinch vary in design with the type of rivet and the service requirements for the assembly. Roll-setting anvils form the rivet into an even, round clinch against the work, against a washer, or, for a pivot pin or a small shaft, in space. Star-setting anvils cut the rivet into six or eight even segments as the clinch is formed. Bifurcated rivets are usually set against a solid form that bends back the prongs and presses them into the work to provide a smooth clinch.

Roll sets and anvils are usually mounted in a cast bracket or machined steel arm which can be raised and lowered by means of an adjusting screw. The holder for a roll set should be as strong as possible to keep breakage and wear to a minimum.

Fig. 9—Three examples of rotary tables used in riveting are shown. In simple operations, a small rotary table *(a)* can be used to position parts under a riveting head. With such an arrangement it is possible for an operator to achieve high production rates since he can load two or more stations simultaneously. A large rotary table *(b)* is used to assemble and rivet two external plates and a sheet rubber seal for an automotive ventilator control damper. The small rotary table *(c)* is used in the assembly and riveting of ball bearings.





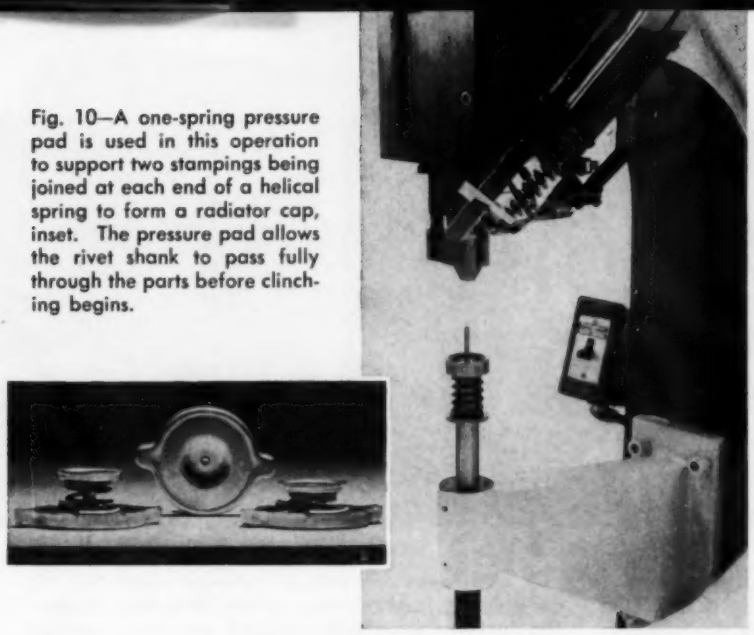


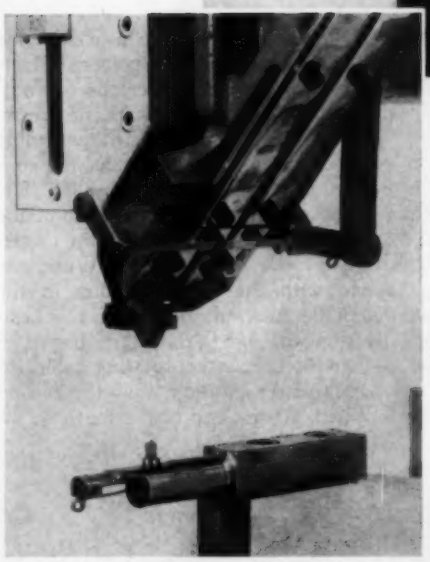
Fig. 10—A one-spring pressure pad is used in this operation to support two stampings being joined at each end of a helical spring to form a radiator cap, inset. The pressure pad allows the rivet shank to pass fully through the parts before clinching begins.

the riveting area, the only difference being that the motion of the table is rotary while that of the slide fixture is linear. A rotary table like that shown in *Fig.* 9*a* is basically a work-transfer device in which successive sets of parts are positioned under the spindle of the machine. In this case, as the rotary table indexes clockwise, each roll set is brought under the spindle. The table is automatically indexed to the next position when a riveting cycle is completed and remains stationary in that position during the subsequent riveting cycle. In the meantime, the parts to be joined can be placed on the plungers of the roll sets on the outer edge of the table. It is evident in such an arrangement that it is possible to achieve a very high production rate, since two stations can be loaded simultaneously, one part at the first station and the other part at the second station (assuming there are two parts).

A more elaborate rotary table for work transfer in *Fig.* 9*b* is required in order to achieve a high production rate even though three different parts must be assembled on the plungers before riveting. Two external plates and a sheet rubber seal in an automotive ventilator control damper are assembled on the five plungers at each of the twelve fixtures by three operators. The five rivets which hold together the three components are set simultaneously by five rivet-setting heads. Each fixture consists of six vertical castings, holding five roll sets and the cam follower for an ejection plate.

As each station is indexed into position under the riveting heads, an electrical switch is closed, and all five riveting machines are cycled. After the riveting operation has taken place, the complete damper is ejected at the next station when the cam follower under the table forces up a hinged ejection plate supporting the assembly. The 12-fixture table rotates once every 36 seconds so that the over-all production rate is 1200 pieces per hour.

The much smaller table, *Fig.* 9*c*, has been designed to increase the production rate in setting ten



(*a*)

(*b*)

Fig. 11—In some cases, the shape of the part being riveted is such that there is little vertical space available below the plunger pin for the usual roll set spring. In (*a*) a vertical spring has been located in the roll-set holder between the fixture base and the plunger pin, and a lever under the plunger transfers force from the spring. A more severe case is shown in (*b*). A small wire form has been located on the outboard end of the roll-set holder to provide the necessary vertical force under the plunger pin.

rivets in a single assembly. A ball bearing is partially assembled over ten roll sets in the roll set holder. The lower stamped metal ball retainer, a preassembly of the inner ring, outer ring, ten balls, and the upper retainer are first placed in position. The lower ball retainer is located by the plungers of the ten roll sets, while the ring-ball assembly and upper

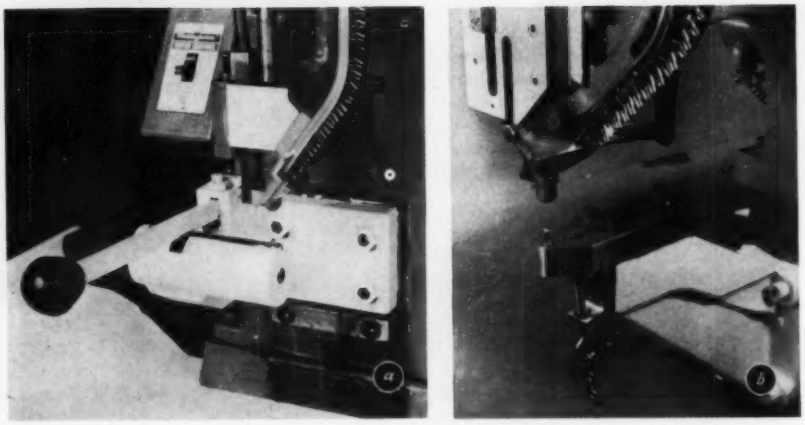


Fig. 12—Two methods of retracting a plunger pin into the nose of a roll set are shown. In *(a)* the pin is lowered by pressing down on the lever on the left of the pin. In *(b)* the pin is pulled down by means of a chain connected to a foot pedal. These fixture arrangements are necessary when the space between the roll set and the jaws of the rivet-setting machine is too small to pass a section of a part that must go over the plunger pin and under the riveting head.

ball retainer are aligned as the balls nest in the pockets of the lower retainer. Of course, the plungers also pass through the holes in the upper retainer. The single-spindle machine sets the ten rivets in sequence through the retainers.

The rings, balls, and retainers are assembled on the roll sets with the pneumatically-powered riveting head in a retracted position. After the operator has completed the manual assembly work, he presses a START button, and the remainder of the assembly operation is performed automatically under the control of an integrated electrical-pneumatic system. The riveting head is moved forward by a double-acting pneumatic cylinder, and the fixed hold-down fingers slide over the top of the bearing rings. When the spindle is aligned with the circle of holes in the bearing retainers, the forward motion of the head is automatically stopped, and the machine begins to cycle. After each rivet is set, the rotating table indexes to the next roll set position, and the setting operation is repeated. At the end of the tenth stroke the machine head retracts, and the hold-down fingers slide off the rings. The operator then removes the completed assembly and begins to set the parts on the roll sets for the next cycle. The riveting cycle itself is performed in less than 10 seconds.

As in many other applications of rotary tables, the substantial decrease in assembly time attained with the automatic table and semitubular rivets more than justified the additional fixturing cost. The potential savings in rotary-table installation are such that larger, far more elaborate tables pay for themselves very quickly in high-volume production. Special features may include automatic sensors to determine whether parts are located properly and inspection stations equipped with automatic rejection chutes.

▶ Other Fixture Variations

In addition to the basic types of positioning and locating fixtures and rotary tables discussed, there

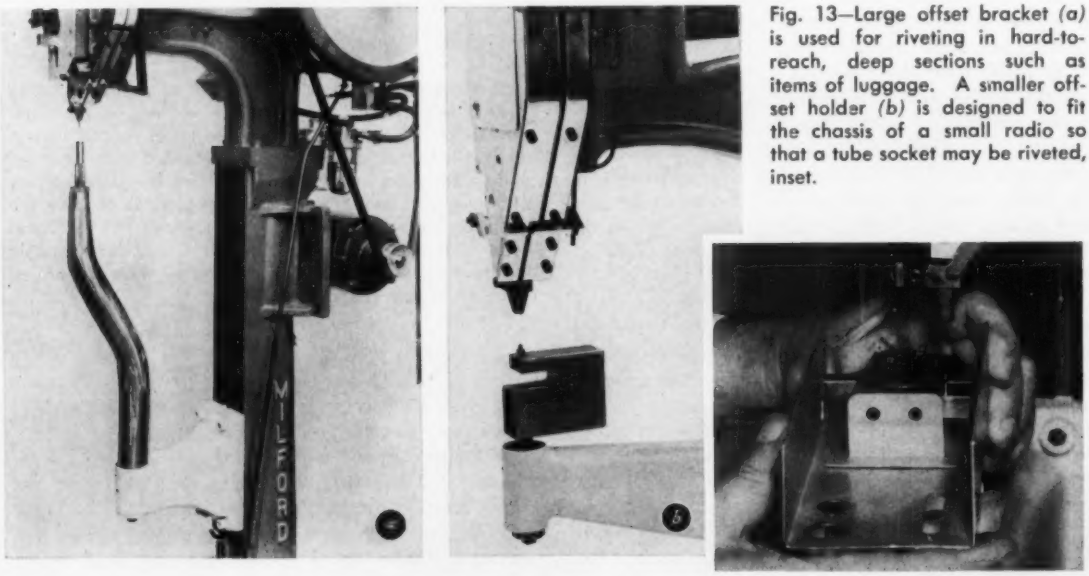


Fig. 13—Large offset bracket *(a)* is used for riveting in hard-to-reach, deep sections such as items of luggage. A smaller offset holder *(b)* is designed to fit the chassis of a small radio so that a tube socket may be riveted, inset.

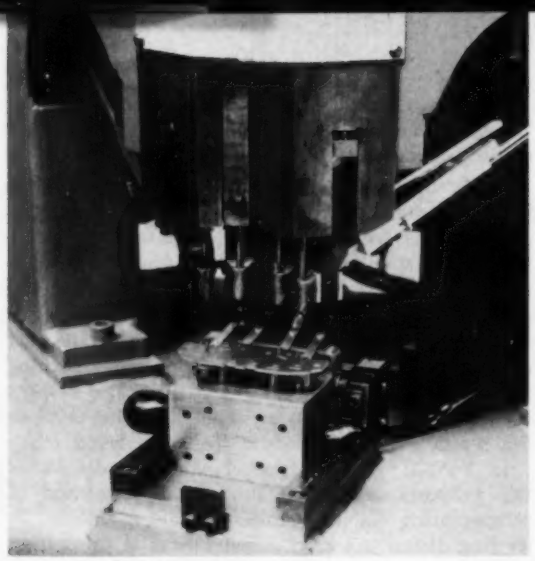


Fig. 14—Work supports are sometimes required in fixtures to hold parts in place for riveting. In this case, a simple metal bar has been attached to the roll-set holder to support four brass contact arms being riveted to a laminated plastic terminal.

are many variations of fixture design which are useful in adapting particular parts to assembly by machine riveting. Although changes are made in part design to simplify or speed up machine riveting, the usual situation is that the riveting fixture must take care of the adaptation with no change in the part design. Since it is certainly wise to avoid, if possible, the additional cost of fixturing, however small, the best practice is for the product designers to consider the needs of the assembly method in the initial development stage. Any problems that may occur in assembly, whether by riveting or another method, can then be anticipated and avoided from the beginning. There are other applications, such as those requiring pressure pads and material thickness compensating devices, where the special fixture design either cannot be avoided or allows an assembly or fastening procedure which produces a far greater net savings in another phase of production.

Pressure pads. Pads are normally used in those riveting applications where there is apt to be interference between the descending rivet and the holes in the parts, particularly the part in the bottom position. As a result, the rivet may lock in the bottom hole so that the rivet head does not seat properly against the top part, and a poor clinch is produced.

While clinching normally begins before the rivet head is fully seated, a pressure pad allows the rivet shank to pass fully through the parts before clinching begins. For example, in *Fig.* 10, a one-spring pressure pad supports the parts in a riveting machine which is joining two stampings at the ends of a helical spring to form a radiator cap. In other cases, the plate holding the fixture is mounted on four corner springs and deflects downward about 1/32 inch before the rivet in the assembly is fully clinched.

Lever-action roll set. The shape of the part being riveted can be such that there is very little vertical space available just below the plunger pin. In these cases, the roll set holder must be undercut severely, *Fig.* 11*a*, so that the parts can be properly positioned for riveting. There is insufficient space available in this case for the usual roll set spring. The required spring force is provided by a spring positioned vertically in the roll-set holder between the fixture base and the plunger pin. A lever under the plunger transfers the force from the spring.

In a riveting operation shown in *Fig.* 11*b* the space limitations are even more severe. There is no room

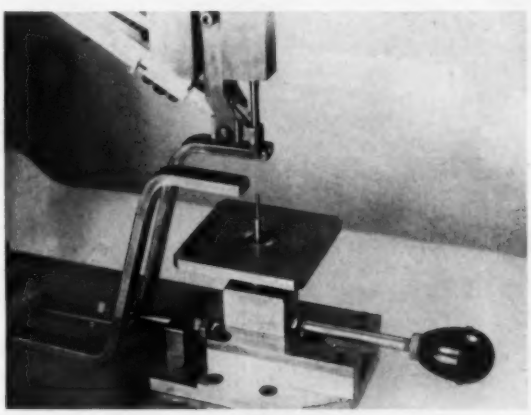


Fig. 15—This work support serves two purposes. It has a spring-loaded leveling table which allows seven rivets of the same type and size to be set at three different levels. It also provides a mechanical means of preventing part projections from interfering with the riveting action.

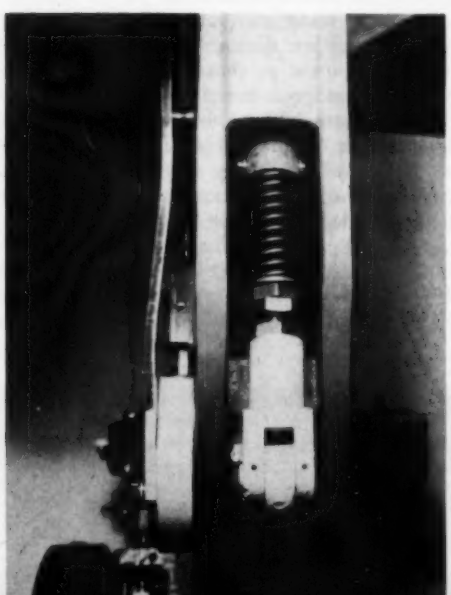


Fig. 16—When fastening materials in which the dimensional tolerances are relatively wide, a material thickness compensating device can be provided. In this case, a coil spring in the connecting rod is adjusted for minimum assembly thickness and will deflect for thicker assemblies without materially increasing the clinching pressure.

in the roll set holder even for the long helical spring. Therefore, a small high-gradient wire form has been located on the outboard end of the roll-set holder to provide the necessary vertical force under the plunger pin.

Retractable plunger pin. Often the space between the roll set and jaws of the rivet-setting machine is too small to pass a section of a part that must go over the plunger pin and under the riveting head. In such cases it is possible to retract the plunger pin into the nose of the roll set while the parts are being loaded for riveting. The plunger pin on the lever-action roll set in *Fig.* 12*a* is pulled down into the anvil by drawing down the lever arm at left. The lever arm is then released, and the plunger pin rises and enters the rivet hole.

With the same problem of limited space, the riveting fixture shown in *Fig.* 12*b* is equipped with a plunger-pull-down pedal. The operator can handle the parts, which may be large or bulky, with both hands while retracting and raising the plunger pin by means of a foot pedal.

Goose neck roll-set holder. In the manufacture of items similar to luggage, it is necessary to provide space both directly beneath and behind the roll set so that large parts can hang conveniently while hinges and other hardware are being riveted. A goose neck roll set holder is shown in *Fig.* 13*a*. Another variation of this holder is shown in *Fig.* 13*b*. In order to rivet a tube socket to a small radio chassis, it is necessary to use a goose neck fixture with a more severe offset. Part of the chassis then fits in under the roll set in the holder while the riveting operation is taking place.

Work supports. The simplest type of work support is demonstrated by the fixture in *Fig.* 14. Four brass contact arms are riveted to a laminated plastic terminal base simultaneously by four pneumatic rivet-setting machines. With the contact arms and the plastic piece set over the four plunger pins, the arms would sag, risking a poor riveting job, unless the four arms were supported. Therefore, a simple, inexpensive metal bar has been attached to the roll-set holder to hold the arms at about the same level as the plastic surface while the rivets are being set.

In *Fig.* 15, another type of work support serves two purposes—a leveling device and a method of compensating for differences in setting height. A leveling device is a mechanical means of preventing nearby projections of the parts from interfering with the riveting action. Otherwise, the operator would have to use his judgment and human errors are liable to occur.

The leveling table in *Fig.* 15 is also spring-loaded, without any connection with the roll set, in order to set seven rivets of the same type and size at three different levels (one, two, and four rivets, respectively) in an electrical switch. Because of this difference in setting height, it was at first thought necessary to use several single-spindle rivet-setting machines with stationary work supports. However, the setting height is self-compensating since the spring supporting the table deflects a different amount at each of the three rivet-head levels.

Material thickness compensating devices. A material thickness compensating device is provided in a riveting fixture to permit fastening materials, often fragile, where dimensional tolerances are relatively wide. Without such a device, either the machine or parts may be damaged if the thickness is on the high side, or the joint may be too loose if the thickness is on the low side. The most common material thickness compensating device is a spring-loaded connecting rod, *Fig.* 16. When the roll set is adjusted for the minimum assembly thickness, the coil spring in the connecting rod, preloaded to take the normal clinching force for that rivet, will deflect for thicker assemblies without materially increasing the clinching pressure. In another device, *Fig.* 17, the roll set itself is spring-supported so that the position of the roll set nose will change to compensate for assembly-to-assembly variations in total thickness. The nominal vertical position of the roll set can be adjusted in the normal way by turning the spring housing in the roll set bracket. This same device may be provided in pneumatic form which may also tend to absorb shock.

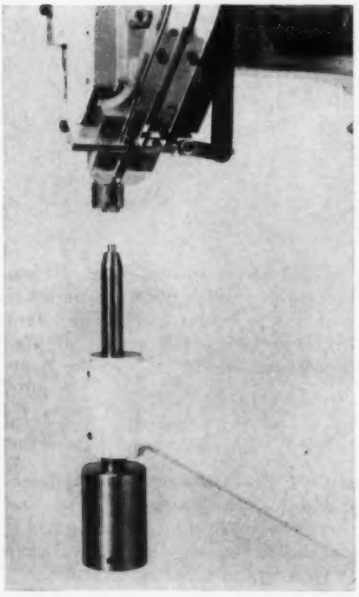


Fig. 17—Another method of thickness compensation is to use a spring-supported roll set. In the example shown, the spring is located in the housing below the roll set so that the roll-set nose will change position to compensate for variations between assemblies.

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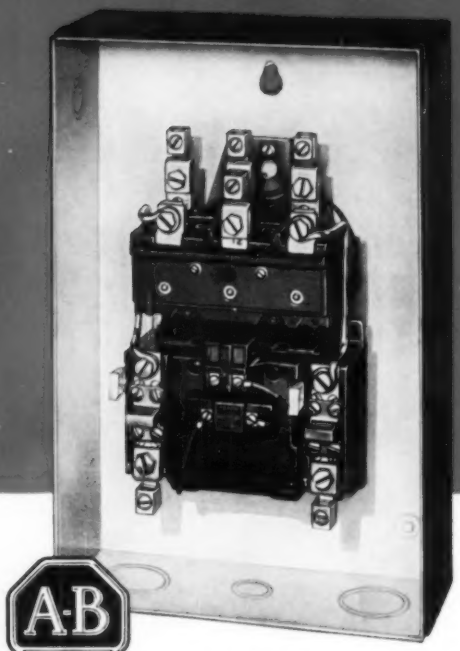
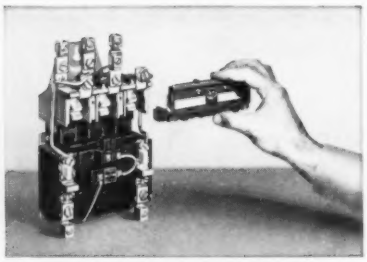
Features of the NEW Allen-Bradley starter line that are of value to you!

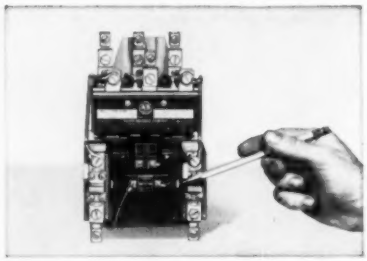


New Bulletin 709 Size 3 across-the-line motor starter. Note the generous space for wiring, accessible terminals, and white interior.

Every detail of the new Allen-Bradley motor starters has been designed to help make this the best line of motor control on the market. Remarkably small in size, each starter is a giant in performance. Being light in weight, these starters are easy to handle and a cinch to install. The generous wiring space, full front wiring, white interiors, and convenient knockouts make installation easy. The enclosure cover is firmly held with a quarter-turn fastener. All installation, inspection, and maintenance operations can be handled from the front—as shown in the illustrations below—without the use of special tools.

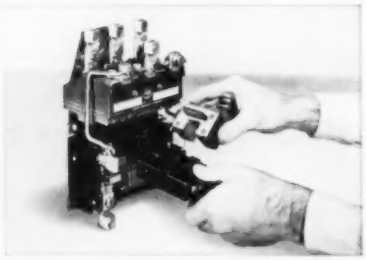


QUICK, EASY CONTACT INSPECTION—When the arc hood front cover is removed by loosening two captive screws, contacts are plainly visible from the front.

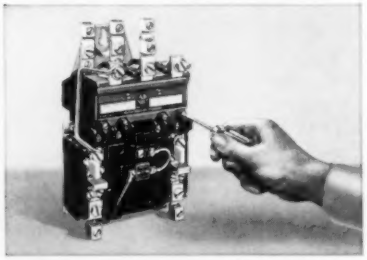


CONTACT POSITION INDICATED—Two slots in the coil cover show the position of the movable contact support—tell whether contacts are "closed" or "open."

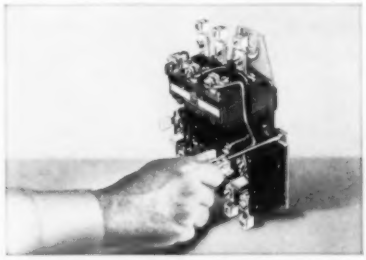
CONTACTS EASILY REPLACED—Depress the spring slightly, and the movable contacts can be lifted out of the molded support and the new contacts slipped in.



COIL EASILY CHANGED—When the coil cover is removed, coil and magnet yoke can be lifted out from the front. They are impossible to replace incorrectly.



AUXILIARY CONTACTS EASILY ADDED to the front of the starter. Two extra auxiliaries can be added to Sizes 0, 1, and 2 starters, and four, to Sizes 3, 4, and 5.



A THIRD OVERLOAD RELAY CAN BE EASILY ADDED in the field, from the front of the starter. And the only tool needed is a common screwdriver.

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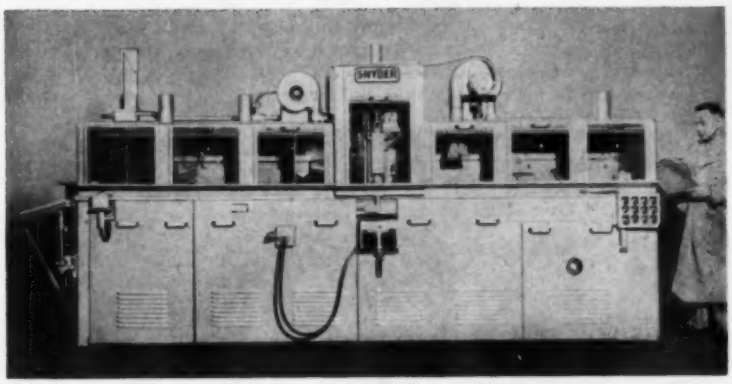
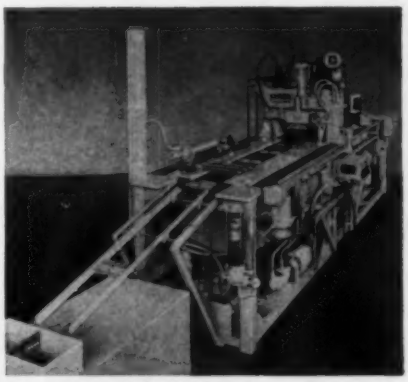


Machine is designed to process electronic printed circuit boards in a 17-second work cycle. It indexes circuit boards from station-to-station by fingers on a stainless steel roller chain that travels in adjustable channel-type ways.



The dip-soldering machine viewed from the unload end with the bonnet removed. The hydraulic cylinder that reciprocates the rotary scrub brushes is on the table near the left hand end of the machine.

Automatic Dip-Solder Machine

STRAIGHT-LINE machine dip-solders electronic printed circuit boards at a cycle rate of one every 17 seconds. Available from **Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich., the ten-station machine is designed to avoid manual or semi-manual fluxing operations as well as bridging and dross problems often encountered in roll-soldering setups. It indexes circuit boards from station-to-station by fingers on a stainless steel roller chain that travels in adjustable channel-type ways. A hydraulic cylinder indexes the chain through a slip-clutch unit. The boards are loaded in the fingers at the first station. In the second station, cellulose rollers apply a water-soluble flux to the under side of each board to avoid gumming and contamination problems. In the third and fourth stations, drying of the top and bottom of the board is accomplished by a high pressure blower that recirculates warm air through that area of the machine.

At the fifth station the dip soldering operation is carried out. The temperature of the solder in the removable solder pot is held to a ±15F tolerance by electric heaters and a thermal barrier. By maintaining solder temperature to these close limits, bridging is avoided along with thermal shock to the boards. The board is clamped to assure flatness and lowered by a hydraulic cylinder for a few seconds into the pot underneath. The board is lowered to a fixed depth, regardless of the level of the solder. This controls the capillary action that causes solder to fill in around each wire lead. The dross is removed from the solder pot by a surface wiper that operates automatically at the completion of each dipping sequence.

The board is cooled in the sixth station where another blower circulates air at ambient temperature to prevent heat of soldering from damaging critical electronic components. In the seventh station the board is washed with a 140F recirculating detergent solution and scrubbed. In the eighth station the board is rinsed with warm water and scrubbed with rotating, reciprocating brushes. Air flows through nozzles from a three-stage blower to dry the board at the ninth station. The boards slide out of the chain automatically into a chute at the tenth station where they are inspected and loaded into portable pallets. The entire machine is provided with a vented bonnet to carry away fumes. Sliding glass panels in the bonnet permit visual inspection and access for each station.

All areas that contact the solder batch or flux are made of stainless steel to avoid contamination. The hydraulically operated, electrically-controlled machine utilizes machine tool-type construction including a hydraulic power pack, centralized lubrication system, and pushbutton controls.

Circle 401 on Page 35

DIGITAL EXTENSOMETER MEASURES STRIP ELONGATION

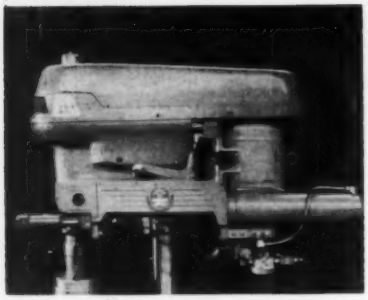
System is designed to improve hardness control techniques for steel mills producing sheet and tin plate. It measures the amount of elongation of cold rolled strip as it passes between the work rolls of a reduction mill. When applied to temper mills, this extensometer has a capacity of measuring exceedingly small elongations (0.5 per cent or less, or 0.062 inch in a 12.500-inch long sample of strip). The system computes and displays continuously the amount of elongation, in per cent, in any one of the following methods: Analog indication (deflection instrument), digital indication (numerical display), continuous record (strip chart), and numerical storage (tape printer). **Allis-Chalmers Mfg. Co.**, Industries Group, Milwaukee 1, Wis.

Circle 402 on Page 35

RACK MOUNTED OSCILLOGRAPH HAS 15-INCH WIDE CHART

Eight-channel, rectilinear writing oscillograph, designated Model RD 2684 20, is ideal as a readout station for telemetry, computer, ground control, testing, and other data acquisition systems where high reliability and precision are required. It has 13 chart speeds ranging from 0.01 to 100 mm per second which can be selected instantly and positively from pushbutton controls on the face of the recorder panel. Analog response of the unit is essentially flat from dc to 100 cps. Dc sensitivity is 1.0 milliamps per chart line, and 1.4 volts per 1 mm chart line. Maximum amplitude of the styli is 40 lines up to 30 cps, 20 lines up to 60 cps, and 10 lines up to 100 cps. **Brush Instruments, Div., Clevite Corp.**, 37th and Perkins, Cleveland 14, Ohio.

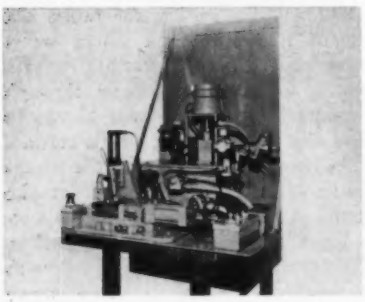
Circle 403 on Page 35



AIR POWERED DRILL PRESS FEEDS

Electrically and mechanically controlled air powered drill press feeds provide rapid advance to the work, the correct drill point thrust, highly accurate depth control, and rapid withdrawal. They are controlled by Hy-Cyclic air valves. Drilling-tapping models will tap direct from a standard drill chuck or multiple drill head, eliminating use of tapping heads, clutches, and leadscrews. Line includes geared head feeds, as well as hydraulic feeds for automating larger drill presses. **Beckett-Harcum Co.**, 985 W. Locust St., Wilmington, Ohio.

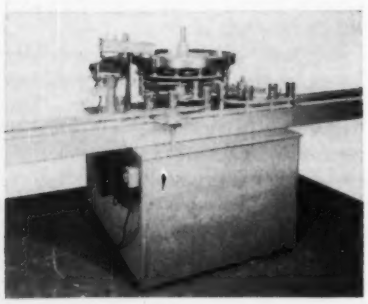
Circle 404 on Page 35



PIN PRESS ASSEMBLES PARTS AUTOMATICALLY

Tru-Tork pin press system is used for pressing extremely small roll pins into parts. The application illustrated is a table mounted system used to press a 0.076 by 0.0138 inch roll pin into the valve end of a rocker arm to secure a spring-tensioned eccentric cam. When the operator places the rocker arm assembly and pushes the master control button, an air-operated fixture is actuated which compresses the assembled part and positions it under the driving head. As it is pressed into position, the assembly itself trips a limit switch which actuates the press head. After the pin is pressed into the hole, the air-operated vise automatically returns to its original position. The entire operation takes place in 2 seconds. **Clyde Engineering & Mfg. Co.**, 937 E. 10 Mile Rd., Madison Heights, Mich.

Circle 405 on Page 35



ROTARY FILLER CAPABLE OF BOTH LIMITED AND HIGH-SPEED OPERATIONS

Unit handles free-flowing powders and granular products. Designated Model CF Whiz-Packer, it can be constructed for limited speed operation involving production of 60 or fewer units per minute, or for high speed requirements with a peak output of 300 units per minute. Complete with intake and output conveyor, this rotary filler is easily synchronized with other packaging machines or may be operated as an independent unit. The unit is capable of handling containers ranging in size from ¾-inch diameter by 2 inches high, to 4-inch diameter by 7 inches high. **Frazier and Son**, 20 Industrial West, Allwood, Clifton, N. J.

Circle 406 on Page 35

A NEW ADDITION TO THE SONAC *LINE*

POSITIVE ULTRASONIC LEVEL CONTROL

The components of Sonac (sensor actual Size)

Now, two new ultrasonic sensors, especially for level control have been added to the Delavan line of SONAC sensing and switching devices.

The single sensor system is recommended for liquid level control and the double sensor system for dry level control.

Control is maintained by installing the SONAC sensor through the wall of the vat, bin or hopper. When the oscillation on the face of the sensor is dampened or impeded by the material being sensed, the signal to the control unit changes, activating a relay.

FIG. 1—LIQUID LEVEL (One Sensor)

FIG. 2—DRY LEVEL (Two Sensors)

For level control, SONAC is accurate to .005" and has a response time of 25 milliseconds. Performance of the sensor does not deteriorate with age.

The level control uses to which SONAC can be applied are virtually unlimited. It is not affected by the viscosity*, specific gravity, conductivity, or capacitance of the material being sensed. Temperature or pressure changes of the material do not alter its performance. False signals are eliminated because SONAC may be adjusted so as not to sense steam, foam, or vapors.

*Viscosity may affect response time.

Canadian Representative:

KNOWLES & FOSTER (North America) Ltd.

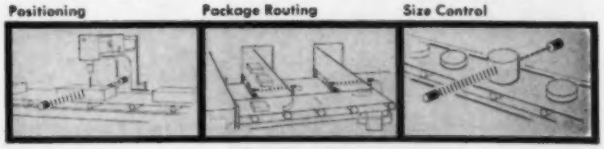
708 Terminal Bldg., Toronto 1, Ontario, Canada

SONAC is extremely rugged. Sensors are type 304 stainless steel. The electronic components in the sensors are hermetically sealed and will withstand pressures to 2000 psi and temperatures from −425° F. to +450° F. They are immune to shock, vibration or mechanical damage.

The control is a compact unit 5" x 5" x 5" and features transistor circuitry. Power consumption is one watt and the unit will operate in temperature ranges from 40° F. to 135° F.

Here's how SONAC can be used for sensing and switching applications other than level control.

Automatic Counting Positioning | Door Control Package Routing | Overheight Signal Size Control



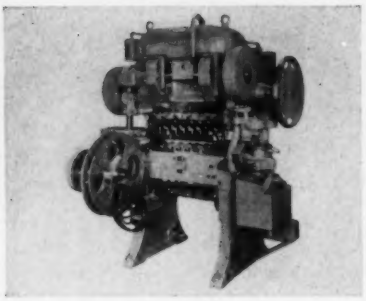
There are dozens of applications for SONAC *single and double sensor units. Let it go to work for you now, write:*

DELAVAN Manufacturing Company

WEST DES MOINES • IOWA

A

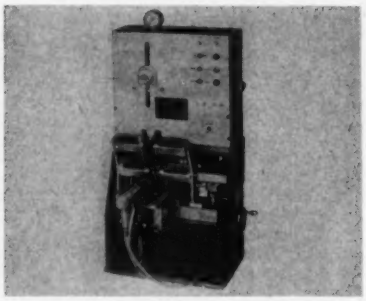
Circle 689 on Page 35



MULTIPLE TRANSFER PRESSES PRODUCE STAMPED DRAWN PARTS

Multiple transfer presses (Model 3-25 illustrated) for producing parts from roll stock feature four new design changes: Longer ram strokes permitting deeper draws and allowing production of a greater range of parts; a roll feed wherein the roll and mounting shaft are constructed in one piece, allowing for easier maintenance; an electric clutch brake which stops the machine in ½ revolution, preventing severe damage to tooling parts; and Empco-bronze bushings located at the transfer finger bearing in the transfer slide, permitting greater accuracy over an extended period of use and resulting in longer life. All design changes have been included as standard items on the complete press line, Models 2-19, 3-25, 4-37, and 5-51. **Baird Machine Co.**, 1700 Stratford Ave., Stratford, Conn.

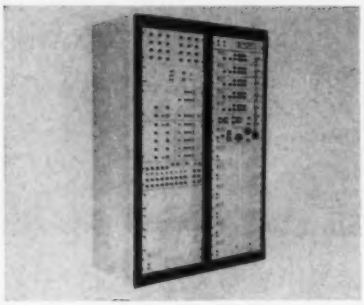
Circle 407 on Page 35



LEAD STRAIGHTENER CAPABLE OF HANDLING SHORT RUN PRODUCTION

Automatic component preparation machine straightens both leads and aligns them perfectly with the body of components. It handles all size bodies and straightens the component leads at 3000 or more parts per hour depending upon the method of feeding. Feature of the Auto-Straightener, Model AUS, is its ability to also handle short run production. Only four simple adjustments are required to reset the machine to handle another body size. The machine is available with a lead trimmer and lead taping accessory for easy coupling to other automation equipment by means of a rear discharge chute. **Design Tool Co., Div., Federal Manufacturing & Engineering Corp.**, 1055 Stewart Ave., Garden City, Long Island, N. Y.

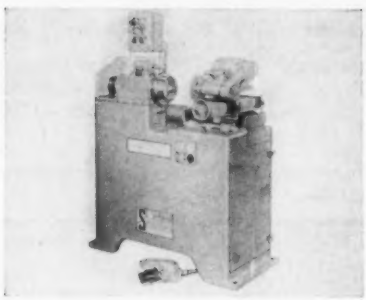
Circle 408 on Page 35



MAGNETIC MEMORY CORE TESTER

Completely integrated system has been developed for the automatic production-line testing of ferrite magnetic memory cores. Type 2102 memory core tester can be programmed to accept or reject cores to a wide variety of specifications. It generates four different programs of current driving pulses which are variable in timing and amplitude. A calibrated sensing system compares core output at five specific times against six known and variable amplitude levels. The tester automatically checks itself by testing a standard memory core prior to each check of the core under test. Both the standard core and the memory core under test receive the programmed pattern of current pulses eight times in order to ensure absolute test accuracy. **Digital Equipment Corp.**, Maynard, Mass.

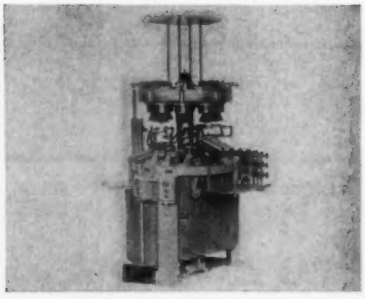
Circle 409 on Page 35



GRINDER FORMED FROM LINE OF BUILDING-BLOCK UNITS

Grinder head is instantly adaptable to a wide range of precision internal and external grinding. It is powered by a ½ hp motor and allows for instant interchange of the 6-inch wheel external spindle for a wide range of interchangeable internal spindles. The head stock is available in a number of designs from internal taper, external taper, through-hole in the spindle, to all types of work holding equipment. Machine illustrated shows the head stock equipped with a collet chuck having an automatic air cylinder. If required, the machine can incorporate a tail stock or the alternative of a universal grinder design, incorporating the wheel head on swivel base and hydraulically powered table incorporating both work head stock and foot stock. **Standard Electrical Tool Co.**, 2550 River Rd., Cincinnati 4, Ohio.

Circle 410 on Page 35



HOT CUT FLARE MACHINE FOR SOFT OR HARD GLASS TUBING

Hot cut flaring machine, Model 3263, handles glass tubing up to ⅜ inch diameter, flare diameters to 2 inches, and flare lengths to 3 inches. Models are also available for tubing up to 2 inches OD, and lengths to 9 inches or over. Length adjustments can be made while the machine is operating. Forming attachments are available for flare spreading, preforming of the flares or other glass forming operations for producing a variety of configurations. The heads and various mechanisms are assembly units which may be easily removed from the machine for servicing. **Kahle Engineering Co.**, 3000 Hudson Ave., Union City, N. J.

Circle 411 on Page 35

1½ MILE OF BUSCHMAN CONVEYORS FILL NEWBERRY ORDERS

Prototype demonstrates automatic transfer from Bush-Lock Overhead Cable carrier to live rollers. Photo-electric unit sorts packages by reading reflective tape labels.

For their new Long Island warehouse, J. J. Newberry Company sought conveyor facilities capable of order picking at many storage racks on two large floors and assembling cartons into completed orders. Buschman built the prototype pictured above, then proceeded to install a complete 1½-mile system of ten overhead Bush-Lock Cable Trolley lines integrated with series of live rollers, gravity rollers and belt boosters. Each cable carrier collects and transports cartons over its entire route, and automatically transfers them to live rollers destined for double-deck shipping lines. Carton labels carrying reflective patterns are read by photo-electric units along sorting conveyor, and cartons are pushed off by air cylinder onto the line assigned to that particular order. The two chain-driven live roller conveyors can move and sort a package every two seconds. Newberry chose Buschman for their superior engineering ability, cooperated fully with them, and in return gained practical, economical, safe and speedy handling.

Write for information on Buschman powered systems and in-stock gravity units for your use.

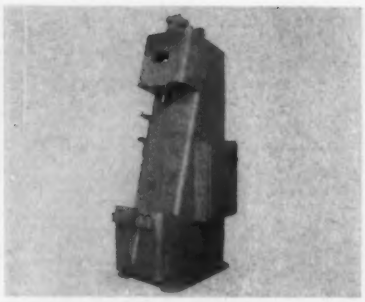
The E. W. Buschman Company, 4551 Clifton Avenue, Cincinnati 32, Ohio

Buschman
CONVEYORS

Complete Conveyor Systems for all Types of Industries: Engineered, Manufactured, Installed. Representatives in Principal Cities; See Yellow Pages.

373

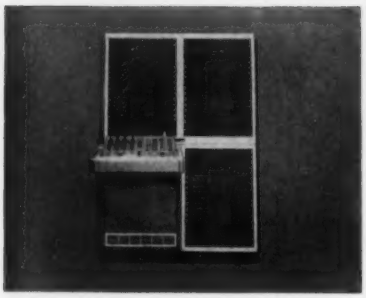
Circle 690 on Page 35



HYDRAULIC PRESS IDEAL FOR VARIOUS INDUSTRIAL USES

Ten-ton capacity high-speed hydraulic press is ideal for broaching, bending and forming, stamping, plastic molding, high-production riveting, plastic and die casting trimming, powdered metal compacting and deep draw operations. It features all-welded, stress relieved, shot blasted "C" frame construction. Standard specifications for Model HFI-10-C-9-23 include: 21-inch stroke, bed area of 9 inches front to back and 23 inches left to right, with height from floor of 30 inches. Approach speed is 120 inches per minute, pressing speed 60 inches per minute, and return speed 120 inches per minute. Ram is 3½ inches in diameter, motor 1800 rpm and 7½ hp. Pump capacity is 10 gallons per minute. Throat is 5 inches and daylight 41 inches. **Sidney Elevator Mfg. Co.**, Box A, Sidney, Ohio.

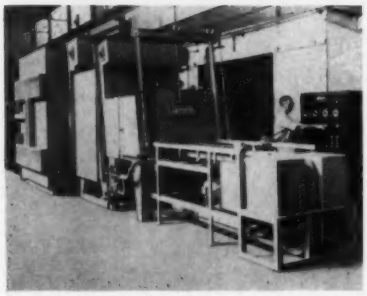
Circle 412 on Page 35



ELECTRONIC CONTINUITY TESTER

Tester quickly checks as many as 6000 individual electronic circuits. It materially reduces time spent in checking wiring of complex electronic equipment. Applications of Model 6000 NIFTE (neon indicator flashing test equipment) range from missile and aircraft wiring, telephone centrals, computers, complex plant instrumentation wiring, as well as simple production cable harnesses. By using this electronic equipment wiring can now be verified in about 7 per cent of the time previously required in one application. The tester has been built in nine various sizes. Of modular construction, it can be used for as few as 50 circuits to over 18,000 circuits. **Autonetics, Div., North American Aviation Inc.**, 9150 E. Imperial Highway, Downey, Calif.

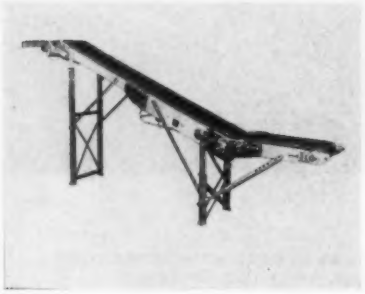
Circle 413 on Page 35



ELECTRIC HYDROGEN ATMOSPHERE FURNACE

Full muffle hydrogen atmosphere furnace is designed for bright heat treating of aircraft and missile steels, stainless steel and also for brazing of stainless steels. Capable of a maximum temperature of 2100 F, the unit is electrically heated and has an accelerated atmosphere quench. It features a new horizontal cylindrical muffle with complete atmosphere lock ahead of the cooling section. There is also a unique heat exchanger built into the atmosphere quench chamber. Operation is automatic. Once the sequence timers are set, the operator presses a button to send the work through the purging, heating, and cooling atmosphere cycles. **Lindberg Engineering Co.**, 2444 W. Hubbard St., Chicago 12, Ill.

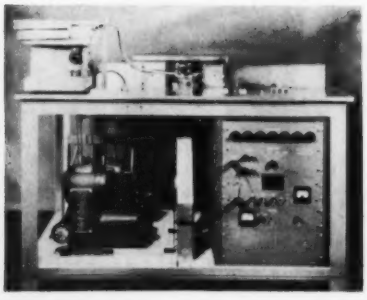
Circle 414 on Page 35



BOOSTER UNIT FOR GRAVITY CONVEYOR SYSTEMS

Continuous flow gravity conveyor systems are easily adapted to inclines from 0 to 34 degrees with a Model FJ powered belt booster conveyor. This unit will also perform efficiently as a floor-to-floor conveyor. The formed steel bed is available in 12, 20, or 24-inch widths and in standard lengths of 5 to 32 ft. Other widths and lengths are optional. Belt speed is 65 feet per minute; other speeds optional. Rufftop belt can be provided with hardwood cleats spaced every 60 inches or to specification enabling conveying at greater inclines. Floor stands are adjustable from 6 to 30 inches infeed height and from 27 to 33 inches discharge height. Higher stand sizes available up to 104 inches. **Hytrol Conveyor Co. Inc.**, 1959 S. 54th St., Milwaukee 19, Wis.

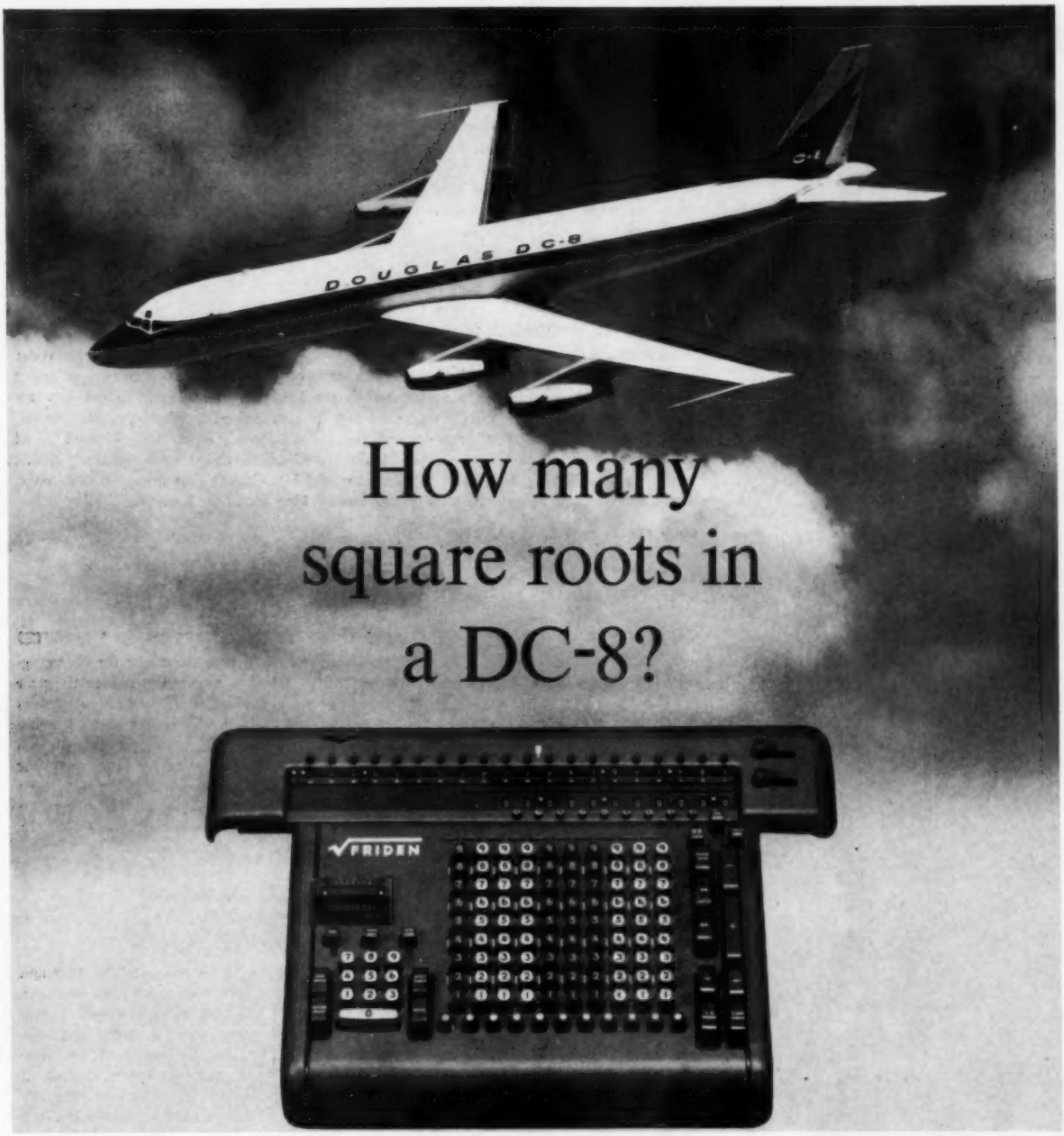
Circle 415 on Page 35



FILM RESISTOR SPIRALLING MACHINE

Resistor spiralling machine, designated Model S-4, applies a helix cut of proper dimension onto a film type resistor (carbon or metal) in such a manner as to tune its resistive value to a predetermined and preset figure and tolerance automatically. In principle it is an automatic lathe, self-loading, self-unloading, which will repeatedly perform the spiralling operation under the guidance of a monitoring electronic controller. The controller will bring all pieces to the same electrical resistance within very close tolerance (±0.5 per cent). The unit will also sort out parts which are defective or which cannot be brought to value. Speed of the machine is up to 60 pieces per minute. **Sigma Engineering Service Inc.**, Box 111, 26 W. Warren Rd., Custer City, Pa.

Circle 416 on Page 35



Thousands? *Tens* of thousands would be more like it. The point is this: if Douglas had used conventional methods of extracting those square roots, the DC-8 would probably have been longer getting off the ground. Ordinary square root methods are both a man-hour bottleneck and a constant source of errors.

How *does* Douglas get its square roots? With the Friden SRW... the only desk calculator in the world that automatically extracts square roots at the touch of a key. Douglas has 54 SRW's. And would hate to have to do without them.

You might not need 54 machines, but it's a rare engineering department that couldn't profit by the addition of at least *one* of these versatile engineering calculators. Ask your local Friden Man to show you what it can do. Or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

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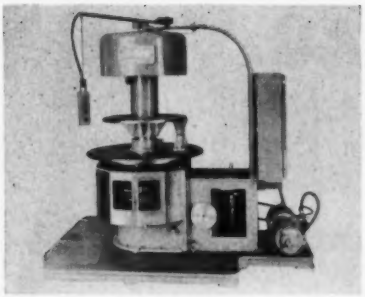
Friden

Sales, Service and Instruction Throughout the U.S. and World

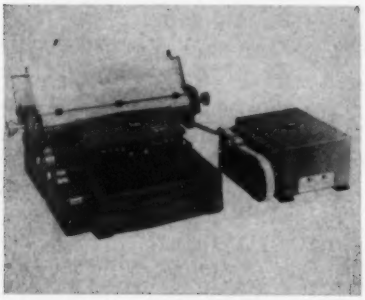
Circle 691 on Page 35



DIAL TYPE MULTIPLE OPERATION MACHINE

Model 60 machine is specifically intended for assembly work and has been designed around many of the recommendations of companies operating automatic assembly equipment. It is ideally suited for the assembly of a large number of components combined with the in-process inspection of the assembly, stage by stage. Coining, staking, crimping, and inserting operations are easily performed from the moving tooling platform without any auxiliary power source. The indexing and tooling motions are all controlled from one central cam shaft. Power pick-offs from the central cam shaft provides auxiliary cam shafts and sprockets to actuate tooling, all timed directly with the main cam shaft. **Bodine Corp.**, 317 Mountain Grove St., Bridgeport 5, Conn.

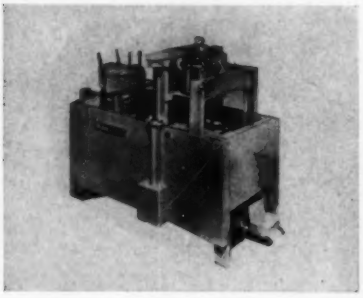
Circle 417 on Page 35



AUTOMATIC WRITING MACHINE FEATURES TAPE VERIFIER

Flexowriter is equipped with a motorized tape reader to prepare and verify codes punched in 8-channel tape. It has been developed to insure the accuracy of input coding for point-to-point or continuous-path machine tool controls, including any intermediate computer functions. By-product tape is prepared as proof document is typed. With tape then inserted in reader, and document retyped, errors will be signaled if new typing does not agree with tape. In absence of errors, new tape is punched. Added feature is a device on the punch to check for odd bits (holes) that make up each code. The machine uses a one-inch wide paper tape. **Friden Inc.**, San Leandro, Calif.

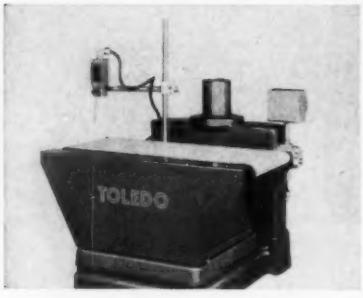
Circle 418 on Page 35



CARTON FORMER CAPABLE OF CHANGEOVER TO NEW SIZES IN FIVE MINUTES

Model PG carton and tray forming machine features a new technique for changing-over from one carton or tray size to another. This method is reported to reduce the time required to make the changeover from one hour to five minutes. The machine handles carton and tray blanks from 5 to 22 inches long by 3½ to 18 inches wide. Certain blanks outside this range may also be handled. The machine was specially designed to accommodate packaging applications where economy of operation and moderate speed equipment are required. Blanks are converted into trays and cartons at speeds up to 70 per minute. Feature of the machine is a closed glue system which permits immediate operation without lengthy make-ready. **Peters Machinery Co.**, 4700 N. Ravenswood Ave., Chicago 40, Ill.

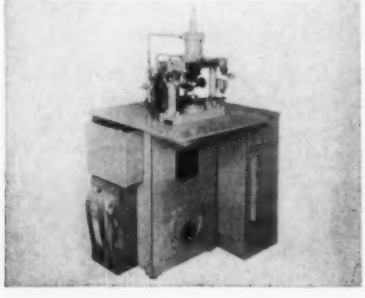
Circle 419 on Page 35



INTERMEDIATE RANGE CHECKWEIGHER FOR IN-LINE USE

Model 9463, designed to checkweigh 2 to 25-pound items, will handle packages up to a maximum size of 12 inches long by 12 inches wide, with a zone edge tolerance of ±¼ oz. Height depends upon package stability. The normal checkweighing rate is 60 items per minute, with faster speeds attainable using shorter length packages. The unit is equipped with a motorized conveyor for in-line checkweighing. It continuously checkweighs bags, cartons, boxes, packages, blocks, cases, or tubes with equal speed and accuracy without stopping the item on the scale. The checkweigher can be furnished with remote zone indication stations that provide a continuous visual check of the operation. **Toledo Scale Div., Toledo Scale Corp.**, Toledo, Ohio.

Circle 420 on Page 35

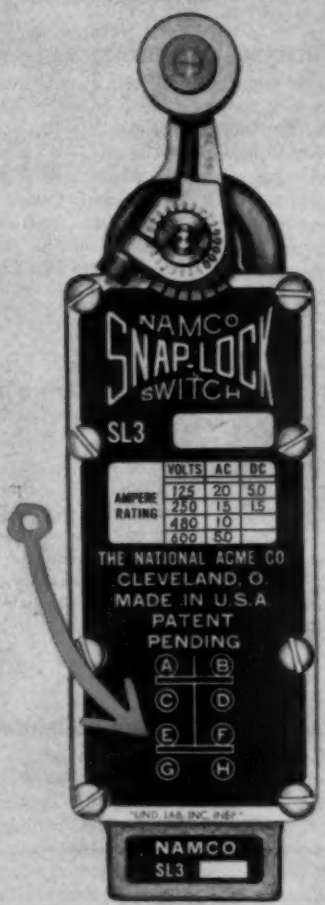


WELDING MACHINE FEATURES LOW INERTIA SYSTEM

Projection welding machine for welding TO-18 and smaller type transistors is designed to improve the concentration of weld pressure around an extremely narrow lip on transistor caps and to overcome pressure drag that occurs at the moment of upset. Designated Model 250, the machine is a two-post, direct tension unit with a low inertia, spring loaded assembly acting as the lower electrode. Machine is available in either a 5 or 10 kva rating. A thyraton control panel includes all necessary electronic devices to properly sequence and time the squeeze, weld, cool and return cycles. Adjustments dictated by work criteria may be dialed into the machine. **Thomson Electric Welder Co.**, 161 Pleasant St., Lynn, Mass.

Circle 421 on Page 35

Take your pick... 1, 2 or 3 normally open, normally closed electrical circuits



What does your limit switching application call for . . . one, two or three normally open, normally closed electrical circuits? Whatever it is, one of these National Acme SL "Machine Life" Limit Switches . . . the SL2, the SL3 or the SL4 . . . will meet your precise requirement. And, every SL offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (10½ lbs. at 1½" radius). Also available . . . the SLS 2, 3 or 4 featuring "hi-shock" sliding contacts; particularly suitable for drop forge, punch press and other heavy equipment application. Call, write or wire for complete information.

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THE NATIONAL ACME COMPANY
196 E. 131st STREET
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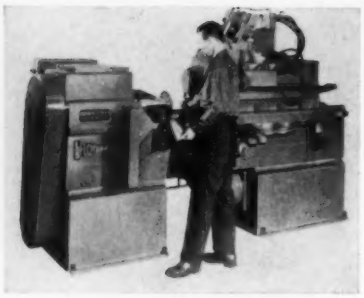
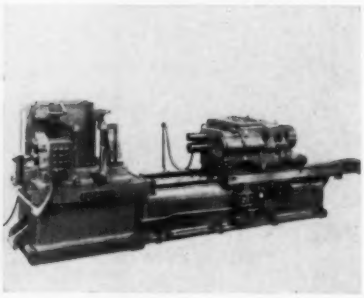
Sales Offices: Newark 2, N. J., Chicago 6, Ill., Detroit 27, Mich.



TRACER-CONTROLLED FORMING MACHINE

Machine is specifically designed for shear forming of lighter gage metals. It features all-hydraulic operation, including automatic hydraulic tracer control of its single forming roller. The No. 12 horizontal precision forming machine produces parts ranging up to 12 inches in diameter and 15 inches long. It is equipped with an 8-speed spindle drive from a 15 horsepower motor or optional variable speed drive. Features include a headstock with precision oversize bearings and automatic lubrication, automatic cycle operation, yieldable tailstock, reversible roller head, 60-degree roller slide, adjustable feed cams, and two separate hydraulic systems. **Floturn Div., Lodge & Shipley Co.**, 3055 Colerain Ave., Cincinnati 25, Ohio.

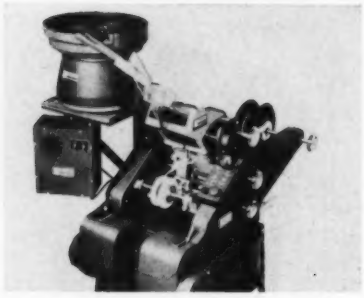
Circle 422 on Page 35



MULTISPINDLE GUN BORING MACHINE

One-way, 2-spindle, central-system hydraulic-feed horizontal boring machine generates long, precision holes simultaneously in large engine crankcases. In addition to boring the crankcase bearings, it also sizes the babbit bushings of the camshaft bore. Machine features hand rotational positioning of the spindles to align the cutters with keyway-type passages in the boring-bar guide bushings. Speed of the camshaft spindle is 3 times that of the crankshaft spindle. The spindle may be positioned by hand, or automated for high production. Separate 3-horsepower hydraulic feed pump provides both feed and rapid-traverse for the return. Adjustable dog stops control the head stroke on the square ways. **Foote-Burt Co.**, 13000 St. Clair Ave., Cleveland 8, Ohio.

Circle 423 on Page 35



LEAD STRAIGHTENING AND TAPING MACHINE

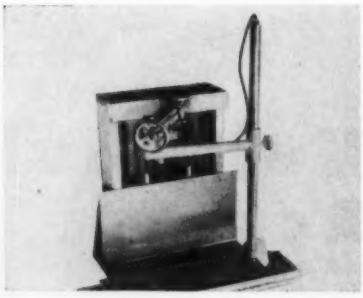
Machine utilizes a fully automatic method for reel packing axial lead electronic components. It is adaptable to either lead taping or body taping and is readily adjustable for any component body length or body diameter within the limits of a model design. Electrically operated and equipped with variable speed control, this machine can be operated for taping or straightening independently if desired. Pick-up reels up to 16 inches in diameter can be accommodated. Optional features include an automatic counting device and a semiautomatic or fully automatic feeding mechanism. Unit is adaptable to both component fabrication or to component processing. **Universal Instruments Corp.**, 139 E. Frederick St., Binghamton, N. Y.

Circle 424 on Page 35

LINKAGE SYSTEM PERMITS COMBINING ANALOG AND DIGITAL COMPUTERS

Computer linkage equipment permits a standard analog computer and any one of several digital computers to be plugged together without individual engineering. The speed of the analog computer, including its ability to solve differential equations in real time is combined with the high resolution, accuracy, and repeatability of the digital computer. Two basic systems, designated Models DS-110 and DS-113 offer 11-bit and 14-bit precision, respectively. Both models are available with up to 30 input and 30 output channels. The systems are designed for use with IBM 700-7000 Series, Bendix G-15, and Packard Bell Computer PB250 computers. **Packard Bell Computer, Div., Packard Bell Electronics**, 1905 Armacost Ave., Los Angeles 25, Calif.

Circle 425 on Page 35



AUTOMATIC STACKER AND FEEDER

Machine, designated the Automator, will convert existing equipment from hand feeding and removal to automatic feeding and removal of work. It is suitable for a wide variety of production operations such as in cutting, planing, sanding, shaping, finishing, roll forming, etc. Unit features a versatile control device which adjusts itself to all variations in workpiece thickness and can be quickly adjusted to changes in machine height and location of work in a wide variety of vertical and horizontal positions. The raising and lowering machine is specially designed to withstand continuous starting and stopping in small, rapid, intermittent steps. It may be used as a regular lift. Movement is precisely controlled. **Machines & Mechanisms Inc.**, Dept. C, 124 Baxter St., New York 13, N. Y.

Circle 426 on Page 35

Circle 693 on Page 35→

POST ELECTRONIC PRODUCTS and CONTROL SYSTEMS

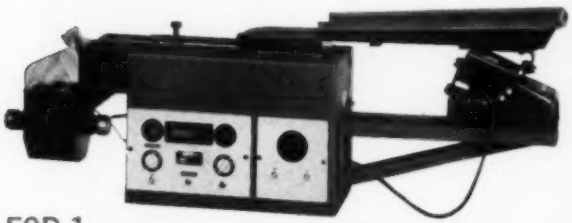
PROVIDE:

AUTOMATION • CONTROL • WATCH DOG RELIABILITY

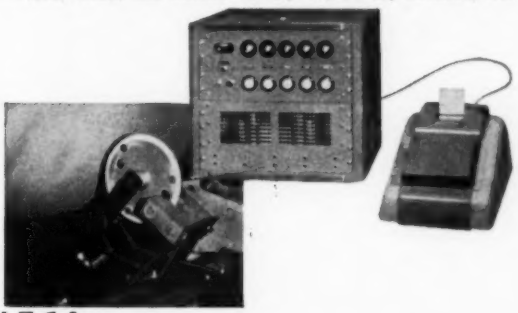
WIDESPREAD ACCEPTANCE is the best evidence of Post's contributions to measurement, and production control. A great variety of problems can be solved by Post electronic products . . . from "batch" counting to paper break detection.

Why not "ASK POST" for an analysis of your particular problem. We will be happy to help you find a solution.

TYPICAL POST DEVELOPMENTS*...



FCB-1 High speed, automatic, small parts counter-batcher. Portable —Feeds, counts and batches small parts, tablets, hardware, etc.



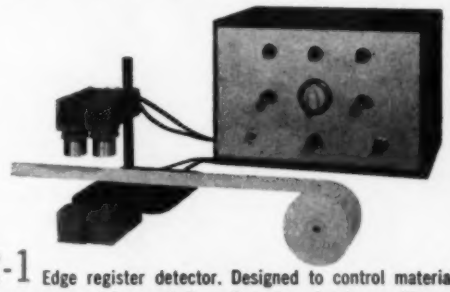
LF-1A Lineal footage measurement, electronically . . . Capable of length measuring continuous production items, i.e., paper, wire, rope, ribbon, etc.

Features visual and printed readout.

P2-RM A preset type counter capable of counting batches in any desired quantity 1-100 (inclusive) with a built-in, 2 scale, rate meter calibrated in "thousands per hour".

PDC The Post "difference" counter . . . capable of maintaining counts of two (or more) variables and acting to control exact difference, i.e., shafts running at different RPM where it's important to maintain "difference" ratio. Many other applications. Adds, subtracts and visually indicates condition.

PW-5 Shown in paper making application. The counter is connected to a lineal footage measuring unit which accurately records paper production. Also provided is a "paper break detector" which will instantly shut off the machine should a web break occur.



ER-1 Edge register detector. Designed to control materials manufactured or processed in a web form. Detects web edge position with extreme accuracy. Inward or outward displacement of web actuates photoelectric control relays for correction.

Get full details on Post equipment today. Check the coupon below.

**These are only a few of the many electronic counters and controls offered by...*

POST

ELECTRONIC PRODUCTS

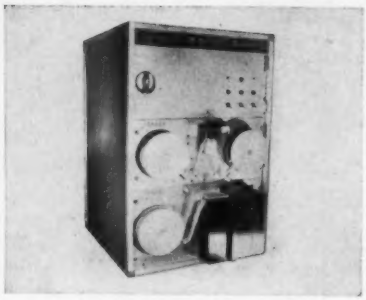
Division of Reid Brothers Co., Inc.

17 LOTHROP STREET, BEVERLY, MASSACHUSETTS

Your special problems are earnestly requested!

Note: Complete line of production line counters available.

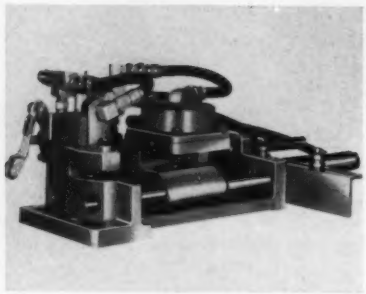
FCB-1	Please send me the following product literature.
LF-1A	
P2-RM	NAME
DFC	TITLE
PW-5	COMPANY
ER-1	ADDRESS
	Please have a representative call



TAPE TRANSLATOR-CONVERTER PROGRAMMED BY PLUGBOARD

Unit has been developed for high-speed translation of paper tape codes and conversion of information between IBM cards and tape. It performs tape code-to-code conversion at 60 tape characters per second. For tape-to-card or card-to-tape conversion, speed is approximately 20 card columns per second. Model 312 uses two standard instruments, a tape reader and a tape perforator for tape to tape translation. For card-tape conversion, the system is linked through its logic section to an IBM Type 024-026 keypunch. Versatile translating capability is provided by a large capacity plugboard. **Tally Register Corp.**, 1310 Mercer St., Seattle 9, Wash.

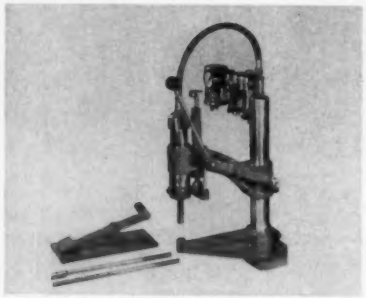
Circle 427 on Page 35



PUNCH PRESS AIR FEED HANDLES LIGHT MATERIAL

Air feed has been designed to feed light coiled material to punch presses at speeds up to 250 strokes per minute. It has an accuracy up to 0.002 inch. Adjustments to accommodate stock being fed to the punch press are made fast and simple. This Junior Model air feed has a capacity to feed materials up to 4 inches wide and thicknesses to 0.06 inch. Timing sequence of the unit is accomplished by means of a roller cam type air valve which is mounted on the side of the air feed. Simple installation of the unit makes it easy to move from press to press in a matter of minutes. It can be mounted to a press to feed material from any direction. **Ses-Matic Press Equipment, Div., Special Engineering Service Inc.**, 7631 Wyoming, Dearborn, Mich.

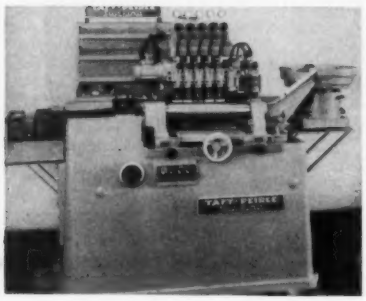
Circle 428 on Page 35



PNEUMATIC IMPACT MACHINE FEATURES INTERNAL VALVING

Bench mounted machine, designated Model 150-RHP-090, is a vibrating or repeating hammer with 9-inch throat clearance and a horn type anvil. It is useful for riveting, staking, inserting bearings and bushings, parts assembling, and for working and shaping sheet metal. Feature of the machine is that valving is internal—there is no outside valve or trigger, and actuation is by contact pressure of the tool on the work. So long as contact pressure is maintained the hammer will repeat, the rate varying from 3000 to 6000 times per minute according to the air pressure used. The action may be regulated from a gentle vibration to a riveting capacity of $\frac{1}{8}$ inch in mild steel. **Heidrich-Nourse Co.**, 631 E. 3rd St., Los Angeles 13, Calif.

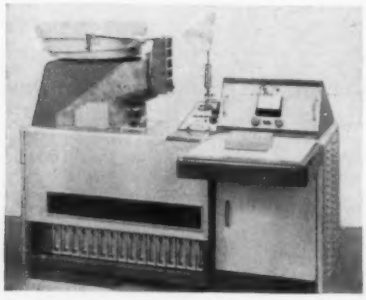
Circle 429 on Page 35



MICROSTONING MACHINE DESIGNED FOR FRACTIONAL MICROINCH FINISHES

Through-feed centerless microstoning machine, designated the Supfina No. 88, is designed for automatic production of fractional microinch finishes while correcting geometric inaccuracies on cylinders from 3/16 inch to $2\frac{1}{4}$ inches in diameter. It will produce finished parts in seconds, unattended. Five stone guides and two heat-treated and ground rolls, are specially designed to feed the work beneath the stones. Five different microstoning operations, from coarse abrading to fine polishing, can be carried out in sequence. The entire oscillating head may be adjusted vertically. Each of the five stone guides may be positioned on the dovetail slide. Roll speed is infinitely variable to give any work feed rate between 10 and 60 inches per minute. **Taft-Peirce Manufacturing Co.**, 13 Mechanic Ave., Woonsocket, R. I.

Circle 430 on Page 35



DIODE TESTERS AND CLASSIFIERS HANDLE BULK LOTS

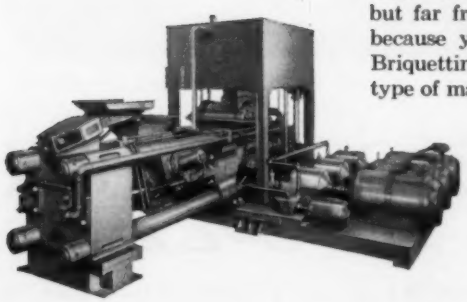
Line of dc automatic testers and classifiers for diodes includes: Model DC-10 (illustrated)—keyboard type, 16 selections, Model DC-20—automatic high-speed, 16 selections; and Model DC-30—automatic high speed, Go-No-Go. These machines are designed for production, engineering, and inspection operations. Production rate is adjustable from 2000 to 7000 per hour. Polarization: Automatic electronic polarizer with "open" and "short" rejection; inverse rejection voltage adjustable from 2 to 5 volts; test circuits are completely disconnected until polarization is completed and testing contacts are shorted during all set-up procedures. **Transistor Automation Corp.**, 101 Erie St., Cambridge 39, Mass.

Circle 431 on Page 35

10302-61

...with a SPO-Milwaukee Briquetting Press!

That's right . . . profits. First of all, briquetting of your chips, turnings and borings will *up-grade your scrap* recovery, and this is like "money-in-the-bank". Next, your scrap storage areas throughout the plant will be available for profitable production operations. Then you must consider that you will reduce your metal loss to an all time low. Last, but far from least, your quality and production control will increase because you can re-use noncontaminated metals of known analysis. Briquetting is the modern and proved way of salvaging virtually every type of machine tool scrap.



Write today for a copy of Bulletin BP-217. It pictures and describes briquetting presses for handling scrap volumes from ¾ to more than 9 tons per hour. Specifications included.

SPO-MILWAUKEE
FOUNDRY EQUIPMENT DIVISION
6306 Grand Division Avenue
Cleveland 25, Ohio

Circle 694 on Page 35

in machine design or modernization...

Fawick simplifies clutch problems

. . . with standardized package design

Fawick Airflex Clutches and Brakes are easiest to use because they are incorporated into simplified *standard packages*, available in a wide range of sizes and capacities, and adaptable to all types of machines.

. . . engineering assistance

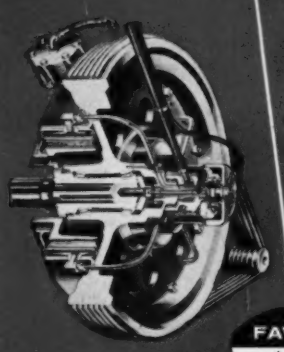
Fawick engineers, at the factory and in the field, are specialists in mechanical power transmission, ready to provide complete engineering service throughout all stages of design or modernization of machine drive systems.

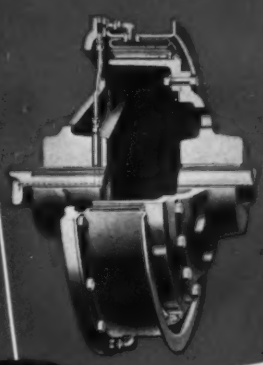
. . . and increased production through top clutch performance

Fawick power transmission packages provide a sure method to increase production, as proved in thousands of applications in all major industries. Their unmatched performance record is based on drum-type air clutch design which provides instantaneous response, low maintenance, automatic self-adjustment for wear and positive safety.

FSPA (Fawick Standardized Press Application)

This clutch and brake package is designed for power presses and other high-speed cyclic machines requiring precise control of single, continuous or inching operations. Package includes CB Airflex Clutch, self-energizing CS Brake, Timing Rotorseal and high-speed clutch controls. On presses in the 5 to 150-ton range, FSPA units may be crankshaft-mounted in combination with flywheel, or clutch and brake may be mounted separately. FSPA is available in 25 sizes with torque capacities from 2,040 to 172,000 in.-lbs. at 75 psi.

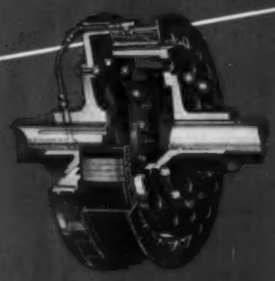




CB Airflex Clutch

Standard complete air clutch may be through-shaft mounted, or used as flexible clutch-coupling between shafts as shown. It compensates for both parallel and angular misalignment. Constricting type unit is designed for high-speed cyclic applications and general power transmission on all types of industrial machinery. It is available in 21 sizes with torque capacities from 2,040 to 1,130,000 in.-lbs. at 75 psi.

FAWICK controls best by AIR



VC Ventorque Clutch

Complete clutch package incorporates ventilated, constricting type clutch for extreme heavy duty applications involving high starting loads or sustained slippage. Rapid heat dissipation insures continuously high torque capacity. Unit may be through-shaft mounted or used as a clutch-coupling. Produced in both narrow and wide series, the VC Clutch is available in 14 sizes with torque capacities from 27,000 to 900,000 in.-lbs. at 75 psi.

Standardized CB Package Application

This small air clutch package may be through-shaft mounted on all types of cyclic machines having moderate power requirements. Tapered bushing construction in standardized bores and mountings simplifies installation and service problems. Package incorporates the CB Airflex Clutch, is produced in five sizes from 6 to 14-in. diameters, with torque capacities from 2,040 to 19,700 in.-lbs. at 75 psi.

For more information on how Fawick can simplify ***your*** *clutch problem, call your nearest Fawick representative or the Home Office.*

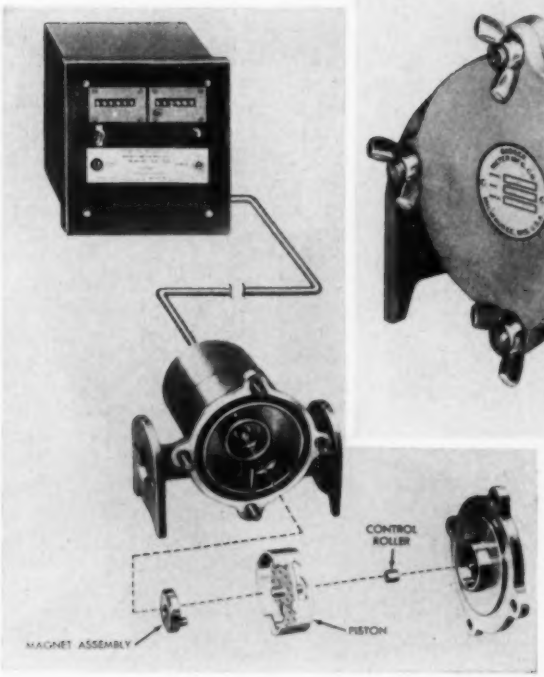
FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK AIRFLEX
INDUSTRIAL CLUTCHES AND BRAKES

AUTOMATION new components

For detailed information and literature, use card page 35.

Parts, elements and devices designed for creating more automatic systems.



Quick, easy cleaning is one of the advantages of this stainless steel meter. By removing four screws on the front of the meter, maintenance personnel can clean the measuring chamber in 5 minutes or less without removing the meter from the line. The gear train, driven by magnetic drive, is in the back of the meter and sealed off from corrosive liquids.

New convenience is provided in the handling of corrosive liquids with this 1-inch stainless steel meter connected to a remote readout. Only three moving parts—magnetic drive assembly, piston, and control roller—come in contact with the liquid.

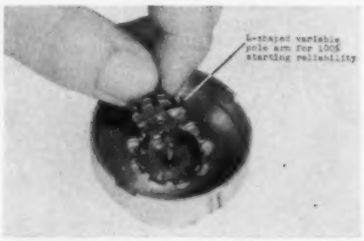
Liquid Metering Equipment

LINE of stainless steel meters with oscillating pistons has been developed by the **Industrial Products Div., Badger Meter Mfg. Co.**, 4545 W. Brown Deer Rd., Milwaukee, Wis., to measure the flow of liquids that would corrode other metals. The line is designed to solve the problems of measuring corrosive liquids for such industries as chemical and paper plants, drug companies, and liquid fertilizer suppliers. The piston, magnet assembly, and control roller—only moving parts that come in contact with the liquid—are inert to a wide variety of liquids. Pistons for the meters are available in several different materials especially selected for certain types of liquids.

The oscillating motion of the piston is transmitted by means of a magnetic couple through the walls of the measuring chamber to a bronze gear train which powers the meter's reading device. Since the meter has no packing glands, the liquid cannot seep out of the measuring chamber to corrode the gear train. Meters are available in 1-inch and 2-inch sizes with several different types of reading devices. The 1-inch size can be installed with either a remote readout or a remote repeat batch controller. The remote readout, with both continuous and reset totalizers, gives industry the convenience of installing the register in an easily accessible place at some distance from the meter. The gear train in the meter drives a momentary pulsing switch, which in turn totalizes the quantity of metered liquid on the remote readout. The remote repeat batch controller, also pulsed with a momentary pulsing switch, provides automatic repeat batching and mixing of liquids from a remote control panel. It is equipped with a six-digit reset totalizer. Two-inch meters can be used with the remote batch control or any of three different reading devices attached to the meter. These include a readout with continuous totalizer to 10 million gallons, another with continu-

ous and reset totalizers, and Electro-Batch with manual preset for batching liquids. Use of the piston and magnetic drive in the stainless steel meters results in accuracy of ±½ of 1 per cent over the recommended flow range.

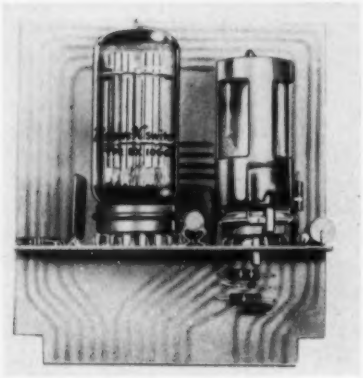
Circle 432 on Page 35



Synchronous Motor

High torque, permanent magnet synchronous motor, the VP-III, has been designed for applications with program timers, computers, displays, and other electromechanical devices. It uses an L-shaped variable pole arm to make it impossible for the motor ever to fail to start because of being on dead center. Standard motor speeds available range from 10 to 1/60 rpm. The motor is available in clockwise or counterclockwise rotation, 115-volts, 60-cycles standard. Standard motor is rated at 20 inch-ounces at 1 rpm. High torque model is rated at 40 inch-ounces at 1 rpm. **Lake City Inc.**, Crystal Lake, Ill.

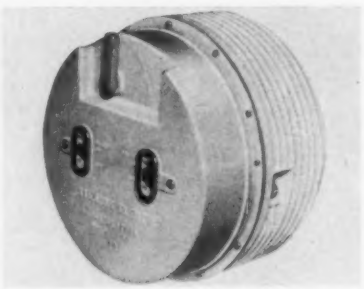
Circle 433 on Page 35



Decade Module

Decade counter module features the ability to perform counting, distributing, multiplexing, and scanning functions by merely reconnecting input and output terminals. Utilizing a general purpose Beam-X switch (BX-1000), this Universal Beam-X Module (DC-112), permits assembly of complex electronic digital systems with a minimum of original circuit design. When used as a counter, it provides direct drive for Nixie indicator tubes, printers, and other circuit devices without decoding matrices or amplifiers. The unit can resolve pulses at 110 kc rates. As a distributor for telemetering, controlling, gating, and similar applications, a pair of modules can commutate 20 positions, generating 2.5 ma constant current output at each point. By making a single connection external to the package, the module can be converted to a scanning device to commutate switches or other points to determine whether information is present. It can be utilized as a variable bit word generator for test instrumentation, coding, and airborne transponder applications. More than 10 positions can be scanned by cascading additional modules. **Electronic Tube Div., Burroughs Corp.**, Box 1226, Plainfield, N. J.

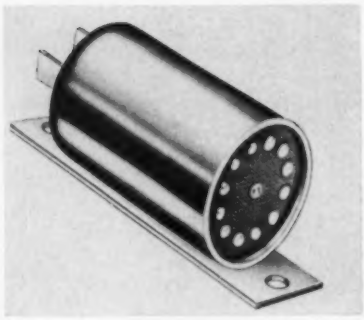
Circle 434 on Page 35



Electromagnetic Brake

Completely enclosed in a housing with torque ratings of 500, 750, and 1000 lb-ft, 46,000 series electromagnetic brake operates on alternating current and is flange mounted. It features unusually high thermal capacities and extremely low WK^2. Need for readjustment to compensate for lining wear can be visually determined from outside the brake enclosure. Manual release-automatic reset is included. Standard motor shaft lengths, or through shafts, can be accommodated. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

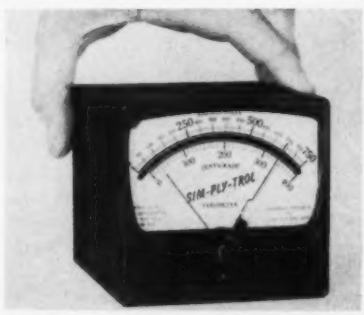
Circle 435 on Page 35



Midget Stepping Relay

Unit, designated Rotomite, is available for multiple applications including business machines, computer circuits, automated devices; also counting, lighting and sorting operations, where limited space is a consideration. High contact rating: 3 amp resistive, 1 amp inductive (50 per cent P.F.) is made possible by contact action, dual make-break, positive circuit isolation contact mechanism. Relay eliminates wiping contacts, bridged circuits, and, in most applications, slave relays. It operates on continuous duty from 3 to 230 v dc; continuous rotation—up to 30 steps per second. No reset in present production items which include dc continuous duty, ac intermittent duty, and ac continuous duty now in development stage. Relay tests well over 1,000,000 operations. It measures 2 inches long and 1 3/16 inches in diameter. **Guardian Electric Mfg. Co.**, 1550 W. Carroll Ave., Chicago 7, Ill.

Circle 436 on Page 35



Temperature Controls

Series of small automatic temperature controls are capable of maintaining heat within ±1 F. The Temp-Tendor controls, designated

another Plus Value by NOPAK

NOPAK

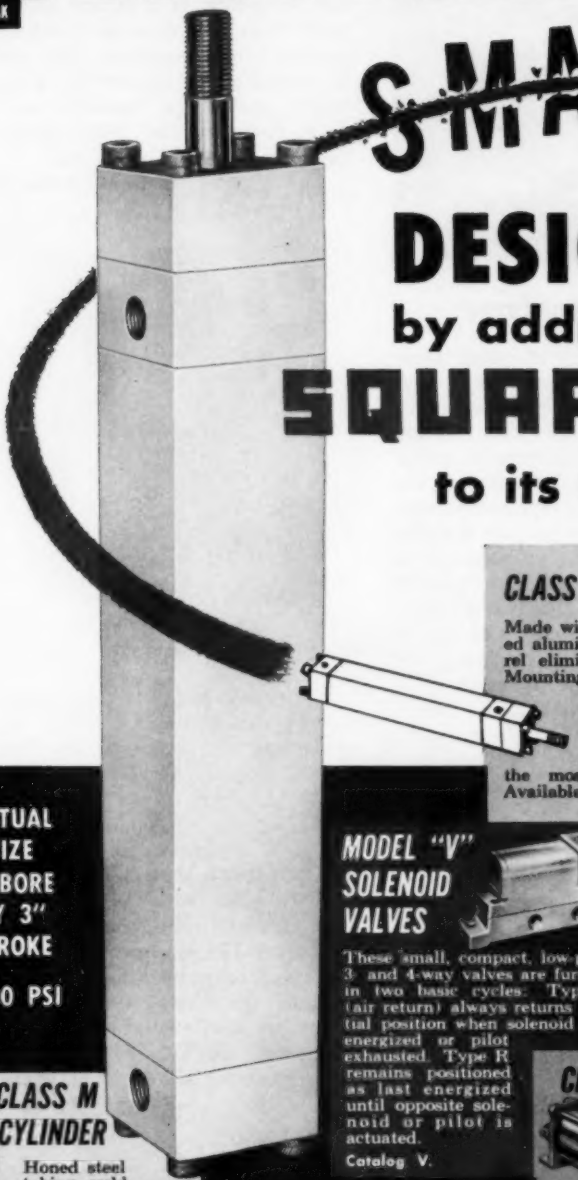
SMASHES

DESIGN BARRIER

by adding world's first

SQUARE BARREL

to its CVA* Products



ACTUAL SIZE
1" BORE BY 3" STROKE
1000 PSI

CLASS 7 CYLINDERS

Made with pressure cast and extruded aluminum. Square head and barrel eliminate the need for tie-rods. Mounting holes can be drilled or tapped directly into cylinder tubing. Cylinders in ¾", 1", 1½" and 2" bores are pressure rated for 200 psi air or 1000 psi oil in the most popular stroke lengths. Available in 7 universal mountings.

Write for Catalog 107.

CLASS 3 & 6 CYLINDERS

Class 3: a compact, steel plate, square-head cylinder with tie-rod and honed steel tubing construction. Working pressures to 3000 psi. **Class 6:** similar in construction to Class 3, but for air pressures to 250 psi; hydraulic to 1500 psi. Square head design permits interchangeable mounting dimensions. Meet or exceed JIC requirements. Available in 18 standard mountings.

Write for Catalog 103 or 106.

MODEL "V" SOLENOID VALVES

These small, compact, low-priced, 3- and 4-way valves are furnished in two basic cycles: Type AR (air return) always returns to initial position when solenoid is de-energized or pilot exhausted. Type R remains positioned as last energized until opposite solenoid or pilot is actuated.

Catalog V.

CLASS M CYLINDER

Honed steel tubing, welded flange construction eliminates tie-rods. For all types of heavy duty air or hydraulic applications at pressures up to 650 psi. Available in 6 standard mountings.

Write for Catalog 101A.

CLASS 1 & 2 CYLINDERS

Class 1: for pressures to 250 psi. Choice of adjustable cushion, self-regulating or non-cushion heads. Diameters from 1½" to 16". **Class 2:** similar to Class 1, but cylinder wall is recessed and gasketed into iron alloy cylinder heads. For pressures to 500 psi — air, oil or water. Available in 6 standard mountings.

Write for Catalog 101A.

NOPAK-MATIC VALVES

Fast acting, high volume air valves in pipe sizes from ¼" to 1¼" with master (air piloted) single or double solenoid. Removing cover plates affords easy access to piston poppets housed within removable, interchangeable cartridges. 100% J.I.C. Easily modified for vacuum operation.

Write for Catalog 105.

ROTATING DISC VALVES

The original NOPAK Valves, available in 2-, 3-, 4-way, and many special cycles for control of cylinders to 500 psi air or hydraulic. Precision lapped rotating disc and body seat are always protected from pressure flow or exhaust.

Write for Catalog 102A.

*C V A — CYLINDERS VALVES ACCESSORIES

NOPAK offers a complete line of Matched Fluid Power Components.

NOPAK
VALVES & CYLINDERS

GALLAND-HENNING NOPAK DIVISION
2734 31st Street
MILWAUKEE 46, WIS.

Circle 696 on Page 35

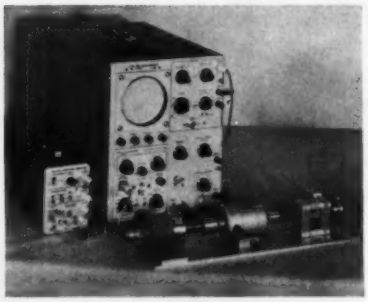
Model 450, are intended for panel mounting with visual signal indication and are particularly suitable for built-in OEM applications. Measuring only 4¼ inches wide, 4 inches high, and 5½ inches deep, these controls utilize a form of proportioning action that minimizes overshoot of the set point and produces an almost flat temperature curve. They are available in 8 standard temperature ranges, between 300 and 2500 F. Special ranges are also available. Controls utilize two standard safety features which cause heat to be turned off if circuit components fail or if thermocouple breaks or burns out. An adjustable potentiometer and a bridge circuit make it easy to compensate the pyrometer for different lengths of thermocouples. **Assembly Products Inc.**, Chesterland, Ohio.

Circle 437 on Page 35

Limit Switch

Highly sensitive proximity limit switch is capable of sensing both ferrous and nonferrous metals. It is applicable where limit switch operation is called for, but environmental or operational requirements prohibit the use of standard mechanical units. Dirt, moisture, or oil that collects on the pickup will not affect operation of the unit. The pickup will not attract metal chips. It can sense through nonconductive, nonmagnetic, and some high resistance metals and can be actuated by high speed, delicate materials, or rough surfaces. Features include a high operational life and ability to operate in submerged fluids as well as in contaminated areas. **Electronic Signals Inc.**, P. O. Box 3811, Cleveland 10, Ohio.

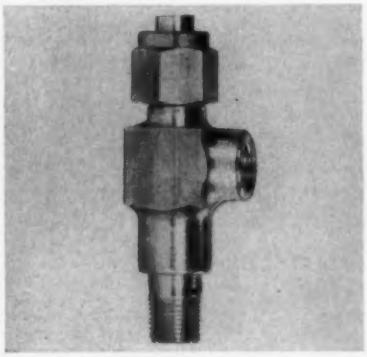
Circle 438 on Page 35



Transducer-Analyzer

Type 182A angle-encoding transducer, center foreground, and Type 183A rotational analyzer, left of oscilloscope, comprise Rotan system. Designed to study rotation-associated phenomena in machinery, the two units adapt an oscilloscope, center background, to provide horizontal trace reflection proportional to angular displacement of a rotating shaft. The setup shown is a wheel-balancing application. The system generates a horizontal sweep representing shaft angle at speeds from essentially 0 to 20,000 rpm. Transduced data, such as velocity, pressure, acceleration, or vibration (applied to the oscilloscope vertical input), appears on the cathode ray tube screen correctly referenced to this instantaneous angular position. **Tektronix Inc.**, P. O. Box 500, Beaverton, Oreg.

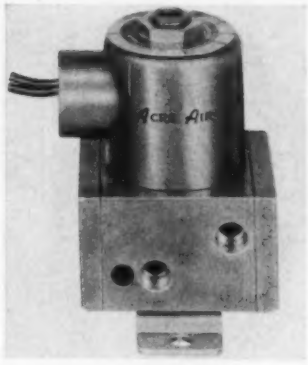
Circle 439 on Page 35



Four-Seal Fitting

Designed to eliminate the need for adapters, connectors, and special fittings when applying pressure gages or other instruments to hydraulic, pneumatic, and process lines, Tylok T-Fitting embodies four positive seals against pressure, temperature, vibration, surge, plus vibration dampener. It is offered in size range from 1/16 through 2-inch diameters with pipe thread. The unit is available in aluminum, brass, monel, steel, and stainless steel. **C. B. Crawford Co.**, 16606 Waterloo Rd., Cleveland 10, Ohio.

Circle 440 on Page 35



Pneumatic Valve

Fast-acting ⅛-inch, 4-way pneumatic valve is single solenoid operated and will work with less than 10 psi in the line. Its aluminum body and poppet-type piston is made of Buna-N bonded to stainless steel. There are no springs in the main body, thus permitting full line air flow with a very small valve. Model I-J-4 operates on pressure up to 150 psi, but higher pressures and other models with either solenoid or other control mechanisms are also available. **Acro Air Associates**, 16736 Foothill Blvd., San Leandro, Calif.

Circle 441 on Page 35

Pressure Control

Control operating range of this Series D pressure control is 500 to 5000 psi. It is available in three

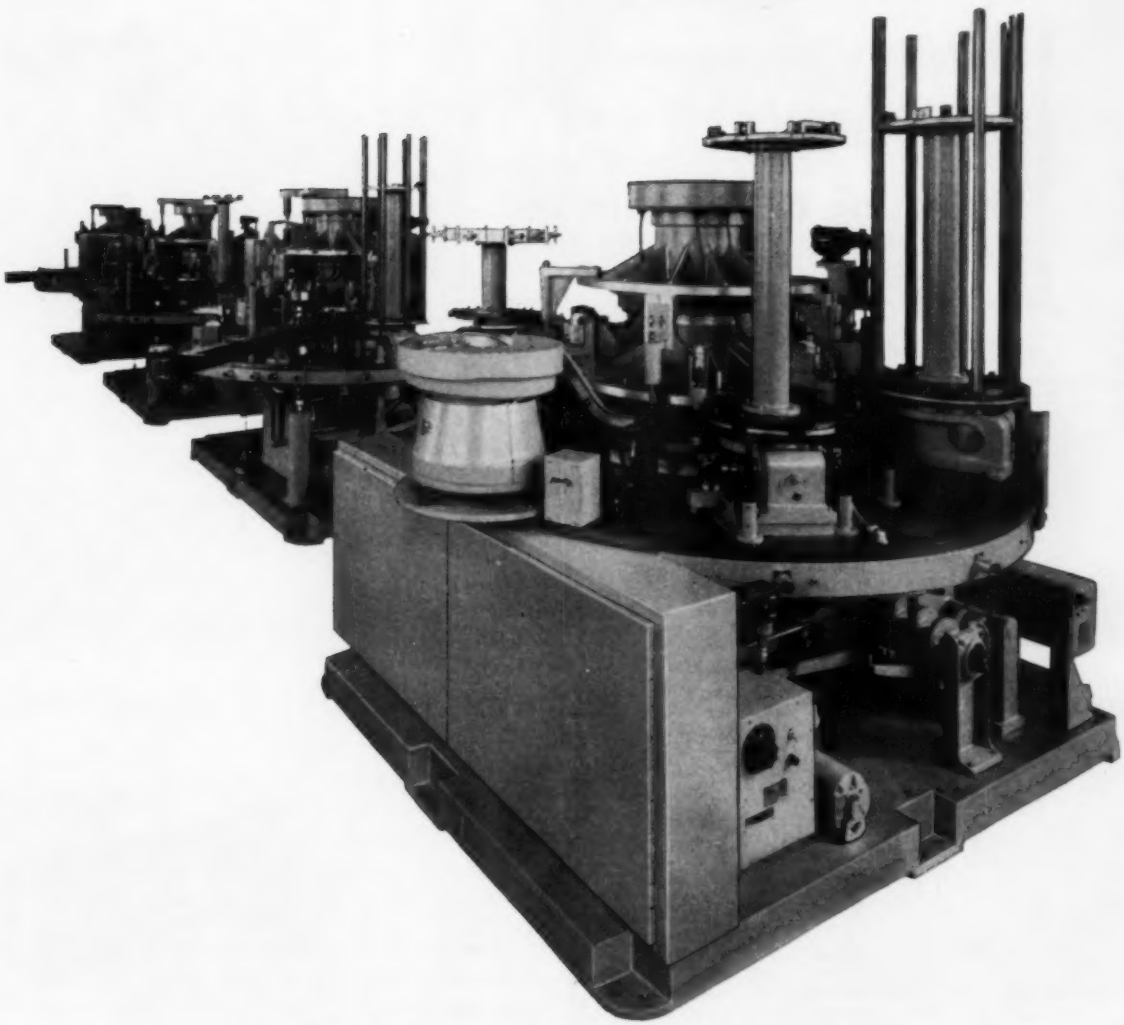
Breakthrough . . .

IN AUTOMATIC ASSEMBLING MACHINES

by Swanson-Erie. These four machines—built around the new Swanson double tool plate chassis—provide multiple motion for piece part assembly. This concept in automatic machine design is another Swanson breakthrough in automatic assembly techniques.

SWANSON Leadership

in new ideas means . . . . better automatic machines for less cost in less time.



A booklet of our products and facilities is available on request.

SWANSON-ERIE CORPORATION

SEC

814 EAST EIGHTH STREET • ERIE, PENNSYLVANIA

Circle 697 on Page 35

IMPORTANT NEWS for
Conveyor Scale Users...

CompuDyne Corporation

announces the acquisition of

TRANS-WEIGH COMPANY

and

AUTOMATIC MEASUREMENTS CO.

to broaden the facilities of
its subsidiary

Weighing & Controls, Inc.

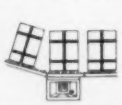
Sales and manufacturing will be consolidated under Weighing & Controls, Inc. Trans-Weigh Co. and Automatic Measurements Co. have specialized in the development of electronic weighing systems. Weighing & Controls, Inc. have developed pneumatic weighing systems. The consolidation of these companies gives industry the most advanced engineering thinking and the highest production efficiency available, for automatic weighing control and data processing. Any system from the simplest to the most complex will benefit from this new, consolidated source.

Whether your problem is in Conveyor Scale, Batch Weighing, Constant Feed Weighing, or Check Weighing . . . in heavy or light industry . . . call W & C.

WC102

CONVEYOR SCALE SYSTEM

CONSTANT-FEED WEIGH-HOPPER SYSTEMS

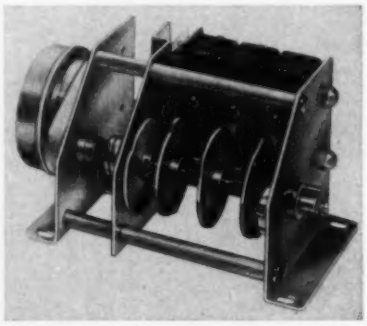

CHECK-WEIGHING SYSTEMS

CONTROL PANELS

Weighing & Controls, Inc.
Subsidiary of **CompuDyne Corporation**
Industrial Park, E. County Line Road, Hatboro 10, Pa.

models: Model DXA-21 minimum operating differential 450 psi, Model DXA-521 minimum differential 200 psi, and Model DXS minimum differential 150 psi. Power element is a welded steel Bourdon tube. The control incorporates a ½-inch IPS bottom connection which is equipped with a special sealing nut having a Teflon insert. Other features are external adjustment, visible dial, and sealed mercury contact with visible on/off circuit position. **Mercoid Corp.**, 4201 Belmont Ave., Chicago 41, Ill.

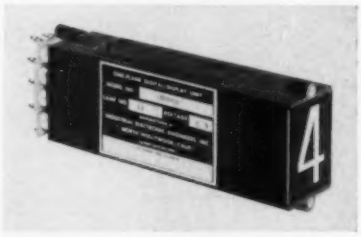
Circle 442 on Page 35



Cam Timer

Series 650 is a multiswitch cam timer designed for original equipment manufacturers. It features an external clutch which permits instant automatic reset, regardless of time cycle. Any time cycle from 1 second to 60 hours can be specified. From 2 to 5 load switches are available, and the timer is also available with adjustable or preset cut cams. **Industrial Timer Corp.**, 1407 McCarter Highway, Newark 4, N. J

Circle 443 on Page 35



Digital Readout

Series 160000 in-line digital readout provides a lens system which permits the use of a larger area of the viewing screen for displaying

Circle 698 on Page 35

Drilling? Boring? Seize Your Numerical Control Advantage

Buy no new jigs and fixtures. Convert storeroom space for useful work. Cut down heavy inventory investment. Tape control is taking over.

More than 500 hours and $5,300 went into making that obsolete drill jig in the foreground. It was used one year. You could make a tape to do the same work for $50, store it in an envelope, revise it for model changes in 20 minutes.

For low volume drilling, milling, turning, and a host of other metal-working operations, there just isn't any other way to beat the cost-cutting ability of numerical control.

Before making new drilling and boring fixtures, write for the bulletin "FPB" describing Fosdick's numerically controlled precision boring and jig grinding machines. Write for bulletin "FTD" describing the 32-spindle Fosmatic Turret Drill. It's time to "get a proposal from Fosdick!"

Write for bulletin "FPB"

Write for bulletin "FTD"

FOSDICK

The Fosdick Machine Tool Company
Cincinnati 23, Ohio

Circle 699 on Page 35

How to get the most out of the money you didn't spend for a new production machine!

What's the top gross geared capacity ever developed on the old machine, **in its very best days**... 55%?... 60%?... 65%?

LIPE A.M.L. Bar Feed Helps You Get Up to 90% of G.G.C. —on Old OR New Machines!

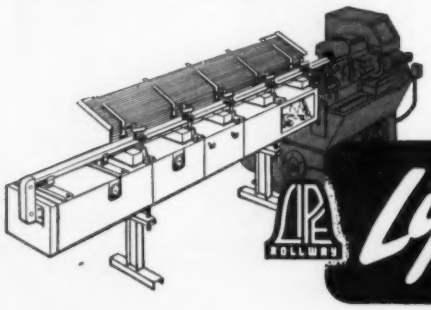
This is documented fact: Users report **massive** production increases whenever production machines — old or new — are equipped with the Lipe Automatic Magazine Loading Bar Feed.

Uninterrupted Stock Feeding Throughout Each 8-Hour Shift

The A.M.L. **continuously** feeds bars, rods or tubing in nearly any shape or diameter from 1/16" to 1½", lengths from 4' to 20'... in any length feed-out. Eight hours of operation delivers eight hours of feeding, no matter what the material: ferrous, non-ferrous, fibre, or plastic. No down-time for adjusting finicky feed-fingers. No "cutting air" while stock is reloaded, **or for remnant removal.**

To get the most out of old OR new production machines, install LIPE A.M.L. Bar Feeds. Sold and serviced by a nation-wide network of franchised distributors in principal industrial areas.

For complete information and name of distributor nearest you, write the company.

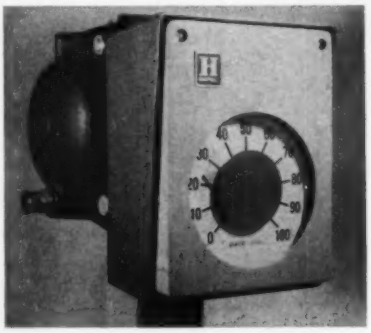


LIPE-ROLLWAY CORPORATION
Syracuse, N. Y.

Lipe BAR FEEDS

digits, words, or special characters. Practically the full area of the viewing screen can now be used. Character size is 1⅝ inches high. Multiple word messages such as Start, Ready, Fire may be employed either in black and white or color. In addition, color backgrounds may be used with any words or digits. The readout contains 12 miniature lamps and 12 condensing lenses which carry the desired character. When one of the 12 lamps at the rear of the unit is lighted, it projects the information on the corresponding condensing lens through a projection lens onto the viewing screen at the front of the unit. **Industrial Electronic Engineers Inc.**, 5528 Vineland Ave., North Hollywood, Calif.

Circle 444 on Page 35



Flowmeter

Pneumatic transmitting bellows flowmeter is available in both indicating and nonindicating models featuring a flapper-nozzle pneumatic circuit, a pilot valve with controlled bleed for stability, and a Ni-Span C rebalancing capsule. The rebalancing capsule reduces zero and span shifts to less than 0.5 per cent per 50 F ambient change. The transmitter provides two-way overload protection while the flow meter itself can take full static pressure overload in either direction. Rotation of the concentric scale indicator, which is 5 inches in diameter with a calibrated length of 8.5 inches, is on a 270-degree arc. This bellows-type differential pressure meter is available in models for measuring liquid level in closed tanks under pressure or vacuum and for flow or open tank measurements. Specifications: Input air supply, 20 ±1 psi; output air signal 3 to 15 psi; accuracy, input to transmission ±0.5

Circle 700 on Page 35

NOW— another FIRST by the Originator of Eddy-Current Equipment

NEW

DYNAMATIC®

Model 905 Ajusto-Spede® Drive

Red tint indicates output member

Extends Capacity Range to 15 HP in the Popular Quill-Type Design

The addition of the new model ACM-905 to the famous ACM-903 and ACM-904 lines of Dynamatic Ajusto-Spede Drives makes the desirable features of Dynamatic Quill-Type design available for many new applications.

Dynamatic Ajusto-Spede Drives provide controlled adjustable speed from an AC power source. Standard control features include on-off clutch control, infinite speed adjustment, constant speed regulation, and jogging. Any of a variety of special features may be easily and economically added to the standard control.

All Quill-Type models are available with either eddy-current, Dyna-torQ, or fail-safe brakes.

An Ajusto-Spede Drive, a control unit (either electron tube or transistorized magnetic amplifier), and a push-button station comprise a compact, easily installed, low-cost drive package.

Check these Ajusto-Spede® Advantages

- ★ Infinitely adjustable speed from AC power
- ★ Simplified construction
- ★ Compact design
- ★ Wide speed range
- ★ Remote control
- ★ Stationary field coils
- ★ Excellent performance characteristics

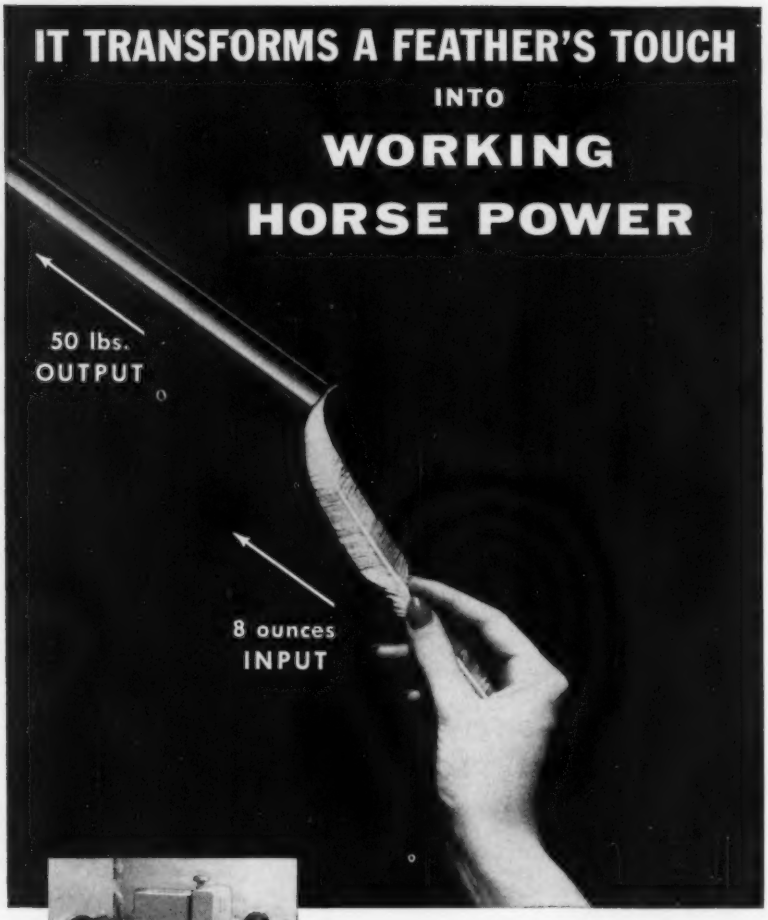
Send for Illustrated Descriptive Literature

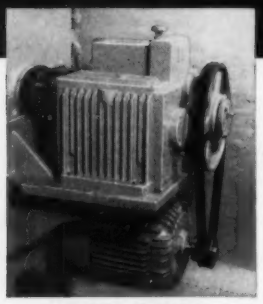
EATON

EATON DYNAMATIC DIVISION MANUFACTURING COMPANY

3122 FOURTEENTH AVENUE • KENOSHA, WISCONSIN

Circle 701 on Page 35





TWO SIZES
MORE COMING

The Seneca Falls Mechanical Power Amplifier is immediately available in two sizes: 30 ft. lbs. torque, and 120 ft. lbs. torque. The larger unit is illustrated above in a combined position and speed control system.

The Seneca Falls Mechanical Power Amplifier is a simple, power servo drive in striking contrast to the more complex electrical and hydraulic devices. Years of service in rugged applications prove its dependability, long life and negligible maintenance.

The Seneca Falls Mechanical Power Amplifier amplifies torque from any control input device

Yes, ANY input source... manual movement, servo motor, synchro receiver—you name it.

Here is a fresh and simplified approach to your power drive problems; an easily maintained unit whose excellent dynamic response permits the design of high sensitivity control systems.

Seneca Falls offers individual control components as well as complete systems including, if wanted, the mechanical assemblies to be controlled.

Write for Bulletin EE 1009
and tell us your problems

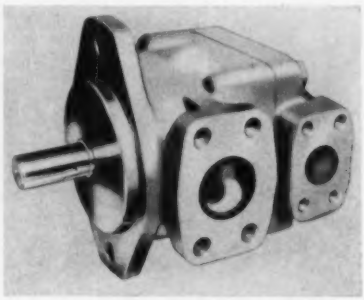
SENECA FALLS MACHINE
PIONEERS IN AUTOMATION

SENECA FALLS MACHINE CO.
SENECA FALLS, N. Y.

Circle 702 on Page 35

per cent F.S., input to indication ±1 per cent F.S.; ambient temperature limits −40 to +150 F. **Brown Instruments Div., Minneapolis-Honeywell Regulator Co.**, Wayne & Windrim Ave., Philadelphia 44, Pa.

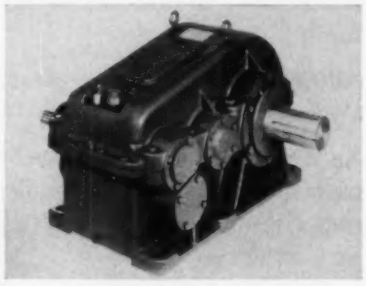
Circle 445 on Page 35



Vane Pumps

Designed for continuous operation at pressures up to 2500 psi and at speeds to 2500 rpm, Series TIC vane pumps are available in four models rated at 8, 11, 14, and 17 gpm, rotating at 1200 rpm and at 0 psi. They consist of a housing with a ball-bearing shaft seal and inlet connection; a pumping cartridge of rotor, vanes, cam ring and a floating front port plate; shaft; and an end cap with a roller bearing assembly and outlet connection. Features include a floating front plate, internal drainage, and a standard 2 bolt C-type SAE mounting flange. **Denison Engineering Div., American Brake Shoe Co.**, 1160 Dublin Rd., Columbus, Ohio.

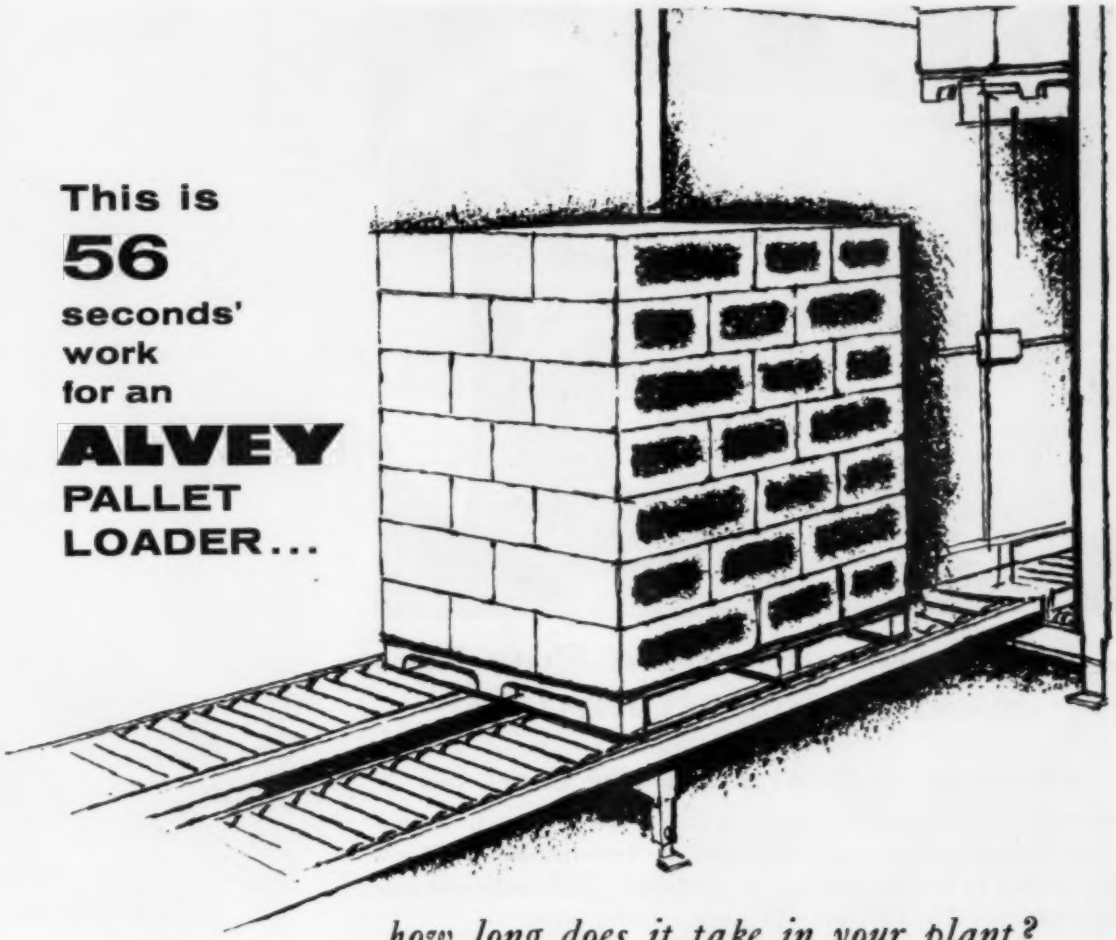
Circle 446 on Page 35



Shaft Speed Reducers

Twenty-three new sizes have been added to this line of parallel shaft speed reducers which now includes a total of 57 sizes. Single, double.

This is 56 seconds' work for an ALVEY PALLET LOADER...



how long does it take in your plant?

1911 1961 ALVEY'S 50th year ALVEY CONVEYOR MFG. CO.

Alvey's Pallet Loader automatically stacks cartons on pallets direct from your production lines, at speeds ranging from 40-60 cases per minute. You pre-set the desired stacking pattern and the number of tiers; the Alvey Automatic Pallet Loader does the rest.

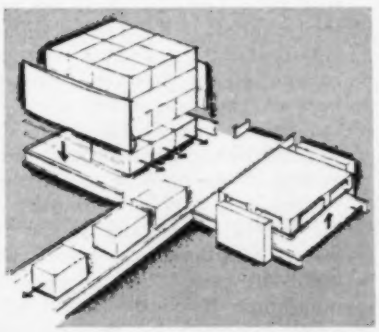
Alvey Loads Pallets In These Patterns And Many More

Nine-case pattern
Column pile

Seven-case pattern
Tiers interlock

Eight-case pattern
Pinwheel pattern
Tiers interlock

Eight-case pattern
Tiers interlock



Alvey's De-Palletizer receives incoming pallet loads, unstacks them and feeds the empty cartons to your handling line at the rate of 45 per minute—all automatically.

When can we talk over your material handling needs?

ALVEY CONVEYOR MANUFACTURING COMPANY

9373 Olive Street Road — St. Louis 32, Missouri

Branch Offices in Principal Cities

Companies like these use Alvey pallet handling equipment:
Coca Cola • General Mills • Hershey Chocolate • Shell Oil • Welch Grape Juice • Western Electric

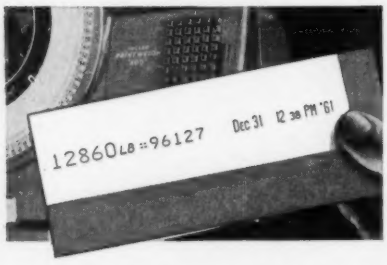
Circle 703 on Page 35

...When Management Puts The Spotlight on WEIGHING

PRINTWEIGH® RECORDS: a Major Cost Control Tool

Materials become money . . . on your scales. Weight records directly affect costs, quality control, inventories and customer billing. That's why it pays to put the spotlight on weighing . . . and make sure you have the right TOLEDO scale at every weighing point.

A close look at weighing is especially called for if you've made changes in plant layout, materials handling methods, or inventory controls. In any of these areas, scales that don't fit the job can bottleneck operations, infect weight records with costly errors.



Complete Printed Weight Records with TOLEDO PRINTWEIGH "400"

Prints complete weight records on tickets, sheets or strips. Transmits weight data to remote locations where it is recorded by office machines, if desired. Ask for Bulletin 2017.

We'll be glad to help you evaluate weighing efficiency in your operations. A few minutes at each weighing station will put the spotlight on scale capacity and location, dial visibility, platform size and height and other important factors. Send for Bulletin 2036. TOLEDO SCALE, Division of Toledo Scale Corporation, Toledo 12, Ohio.

(Toledo Scale Co. of Canada Ltd., Windsor, Ont.)

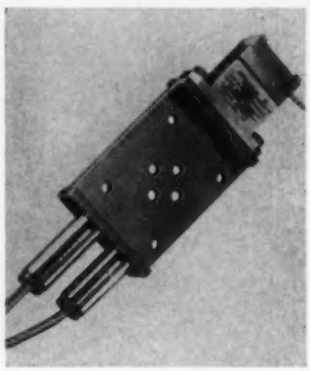
SERVICE Factory-Trained 340 Cities

TOLEDO®

Headquarters for Weighing Systems

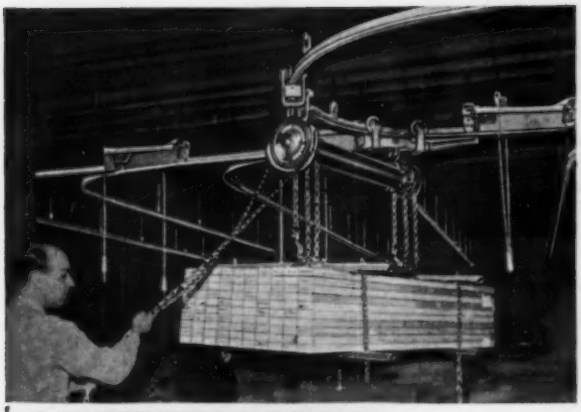
and triple reduction units are available in capacities up to 2800 hp at high or low output speeds and ratios up to 292:1. Shafts can be arranged to suit specific drive requirements, and can be assembled with single shaft projections in either direction or with double shaft projections. Line includes single reduction units in 17 sizes with ratios up to 9.78:1 and capacities to more than 2800 hp; double reduction in 20 sizes with ratios from 11.4:1 to 70.6:1 and capacities to more than 1700 hp; and triple reduction in 20 sizes with ratios from 31.4:1 to 292:1 and capacities to more than 900 hp. **Link-Belt Co.**, Dept. PR, Prudential Plaza, Chicago 1, Ill.

Circle 447 on Page 35



Valve Monitoring System

Servo valve monitoring system, designated Model 1000-7, consists of three pressure transducers mounted on a thin manifold block which fits between the servo valve being monitored and the hydraulic system manifold. A 3000 psi differential transducer gives a constant readout of the pressure difference between the two control ports of the servo valve. A 3000 and a 300 psig transducer gives constant indications of the pressure at the supply and return ports. Accuracy of the system is the same as for the Series SP2 pressure transducers which are used. Typical specifications are: Nonlinearity and hysteresis combined, less than 0.25 per cent of full scale; thermal zero and sensitivity drift each less than 0.015 per cent of full scale per degree F from −65 to +275 F; combined errors from all sources less than 0.5 per cent of full scale. Unit has



Hand chain twin hook hoist transports stock from storage to processing. This low cost monorail system permits maximum use of plant floor . . . wide aisles are not needed since bulky loads of lumber travel above fabricating equipment.

Louden Monorail Handling System provides live storage for leading tractor manufacturer. Here engines are received, stored and transferred to test line on smooth running Louden trolleys, all without rehandling.

Leading producer of glassware reduced cost of mold maintenance with monorail system and chemical method of cleaning. Molds are loaded on pallets and automatically travel through the cleaning cycle, stopping and dipping molds into chemicals.

Cab controlled "shuttle carrier" travels via monorail throughout large metal fabricating plant. Monorail carriers make possible close grouping of production machines because space travel of materials clears aisles for production.

UNTANGLE PLANT TRAFFIC WITH MONORAIL

Clear the aisles for production . . . use monorail for materials handling. Suspended from the ceiling, a Louden Monorail Handling System removes traffic from the floor, saves floors for production. Not only does this untangle plant traffic, but also increases plant capacity and becomes a big factor in cutting cost of floor maintenance.

A Louden Monorail Handling System moves raw stock, semi-finished and finished products over the heads of men and machines, and its exceptional flexibility makes it ideal for all types of handling requirements. It can transport materials from point to point anywhere in your plant, either piloted by an operator or completely unattended. Materials can travel from floor to floor, building to building, opening and closing doors, pass through one processing stage after another, and even load and unload its own carriers with certain classes of materials.

When you have material handling requirements, call on Louden, the pioneer of monorail handling. Benefit by Louden's unequalled experience and broad array of service-proven equipment. Most Louden installations pay for themselves in months; some have done so in a matter of weeks.

Louden

MONORAIL & CRANES

SINCE 1867 . . . THE FIRST NAME IN MATERIALS HANDLING

NEW **. . . 52 pages of illustrated applications . . . industry by industry. Get the latest and most complete information on planning and equipment selection for the best in modern materials handling. Write today for your copy "COST-CUTTING WITH MONORAIL AND CRANES." The Louden Machinery Company, 616 Broadway, Fairfield, Iowa.**

THE LOUDEN MACHINERY COMPANY

A Subsidiary of Mechanical Handling Systems Inc.
Plants in Fairfield, Iowa and Clark, New Jersey

Circle 705 on Page 35

with MILFORD "MULTIPLES!"

The "Multiples" that keep assembly costs down while increasing production and profits are standard Milford rivet-setting machines operating as a unit. The Milford line is designed as "building blocks" for multiple units to suit your automatic riveting needs. They can be flexibly regrouped to meet the next, low cost assembly requirement.

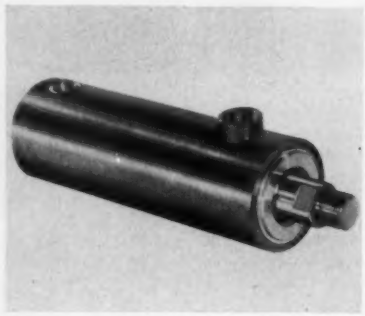
The narrow wedge shape of Milford's No. 56 and 57 permits grouping to set rivets head to head and, when grouped, **the cost of labor and burden is divided by the number of heads in the unit.** Write for Milford's Engineer's Kit, so you can explore the profit multiplying possibilities of Milford "Multiples" first hand. *Or we'll be glad to quote on your needs immediately.*

THE MILFORD RIVET & MACHINE CO.
MILFORD, CONNECTICUT • HATBORO, PENNA.
ELYRIA, OHIO • AURORA, ILL. • NORWALK, CALIF.

Circle 706 on Page 35

provision for shunt calibration. A calibrating resistor of 40 K ±0.05 ohms will cause an electrical output which is within ±0.25 per cent of half of the full scale output. Residual unbalance at zero output is less than 2 per cent of full scale at rated excitation. **Standard Controls Inc.**, 1130 Poplar Place, Seattle 44, Wash.

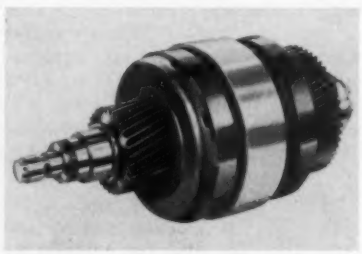
Circle 448 on Page 35



Cylinder

Cylinder is designed to reduce cost, weight, and space factors. Its design eliminates bulky tie rods, head bolts, packing glands and permits operation at pressures in excess of 3000 psi. The Deccto cylinder features a cylinder head that floats microscopically within the cylinder bore and automatically maintains alignment and concentricity between the tube and rod axis. A wide range of mounting configurations enables this device to be installed in automotive, aircraft, industrial, machine, and military ordnance applications. **Bruning Co.**, P. O. Box 147, Lincoln, Nebr.

Circle 449 on Page 35



Hydraulic Clutches

Line of Power Shift hydraulic clutches is available as components for a wide range of transmissions and machinery. They have been designed to drive off-highway wheeled and track laying vehicles, switching locomotives, marine gears, cable and winch drives, prime movers, front end loaders, forward-reverse units, and machine tools. Available in 6 sizes to handle torque loads from 1000 to 10,000 lb-ft, engines up to 1000 horsepower, and speeds up to 5500 rpm, these clutches feature a dual-drive design which provides end-to-end shifting with extremely smooth and fast engagements. They shift and engage in less than 0.6 sec. One clutch is actually two clutches on one shaft. Single-drive clutches are also available. **Rockford Clutch Div., Borg-Warner Corp.**, Rockford, Ill.

Circle 450 on Page 35

Yarn Inspection Device

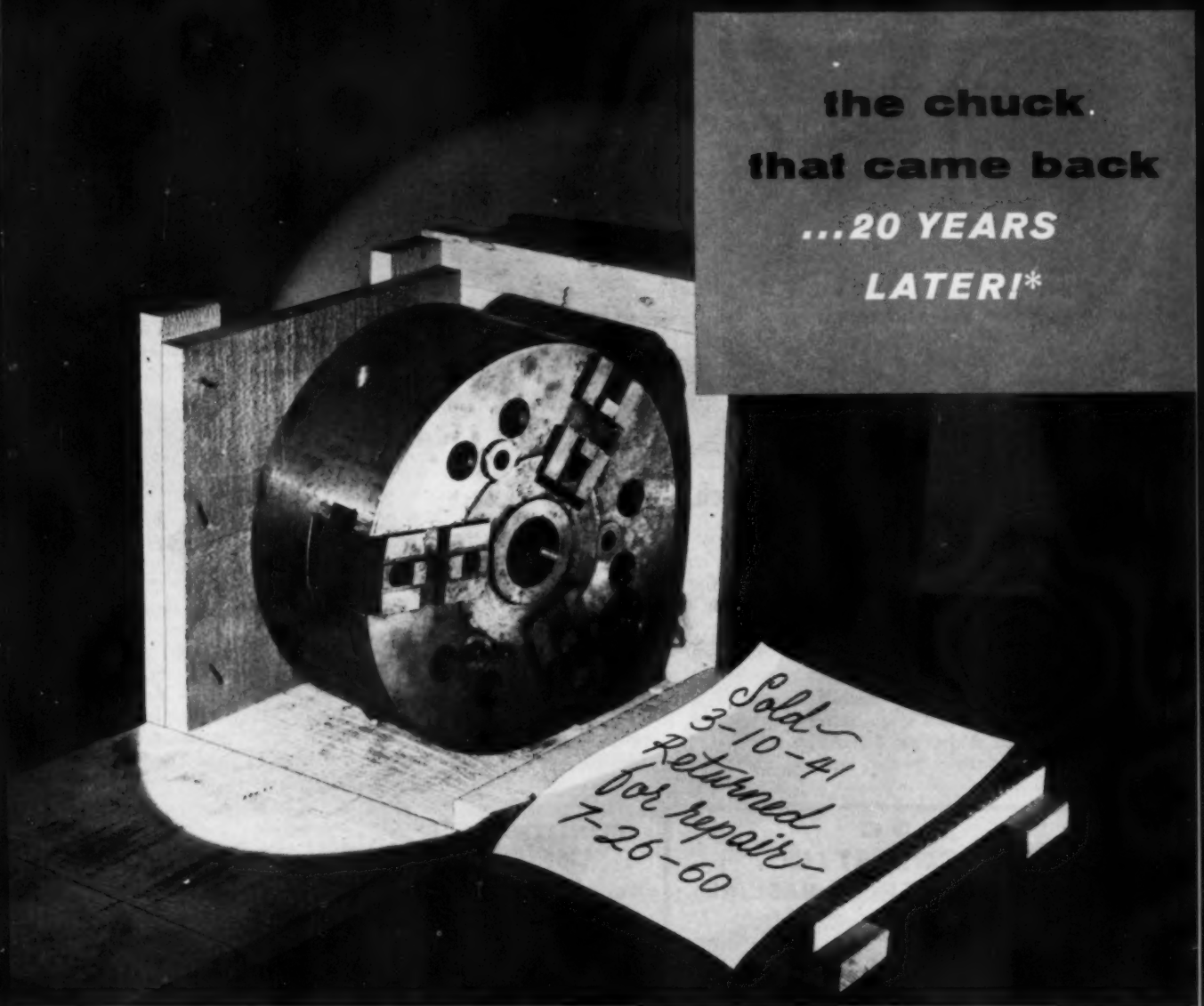
Electronic device is designed for use as an accessory with a warp yarn monitor. The Detect-All Mark II detects and counts linear defects and end breaks and stops the warper for their removal. Feature of the system is the inclusion of a cathode ray oscilloscope. Detector signals are continuously monitored on the oscilloscope screen so the operator can identify and remove the sources of interference. **Fabrionics Corp.**, Box 521, Huntington, N. Y.

Circle 451 on Page 35

Electronic Control Meter

Meter operates without electrical contacts and provides continuous output signal past control setting

the chuck that came back ...20 YEARS LATER!*



This chuck was returned for refurbishing after 20 years of service!

Actually, this is not an out-of-the-ordinary service record for Logan chucks, because they are built throughout with extra factors of strength and durability to resist deflection, misalignment and wear—and to deliver accurate, dependable and efficient service year after year on any type of operation.

If you would like more information about these rugged, long-lasting air and hydraulic chucks, or any of Logan's other products, just fill out the coupon below.

**Customer's name furnished upon request.*

LOGAN

AIR AND HYDRAULIC OPERATED MACHINES

Check the items you want, fill in your name and address, tear out and mail to:

Logansport Machine Co., Inc. · 730 Center Avenue, Logansport, Indiana

___100-1 AIR CYLINDERS
___100-2 MILL-TYPE AIR CYLS.
___100-3 AIR-DRAULIC CYLS.
___100-4 AIR VALVES
___100-5 LOGANSQUARE CYLS.
___100-6 ULTRAMATION CYLS.
___100-7 SUB-PLATE AIR VALVE
___300-1 CHUCKS
___300-2 PRESSES
___200-1 HYD. POWER UNITS
___200-2 ROTOCAST HYD. CYLS.
___200-3 750 SERIES HYD. CYLS.
___200-4 and 200-7 HYD. VALVES
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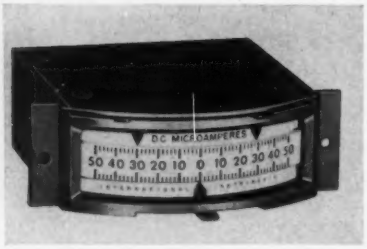
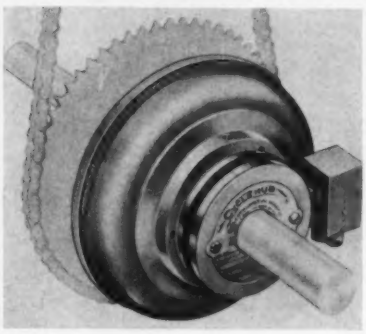
Circle 707 on Page 35



with accurate, uninterrupted full-scale indication and automatic resetting. Model 2547 is ideally adapted to current concepts of miniaturization and the employment of modular apparatus. Contactless operation, with no electrical contacts at the control point, eliminates contact resistance, flutter, corrosion, and spot welding. It also permits accurate full-scale indication at all times. Meter is available in two standard models, with single or two independent control-arm circuits and is available with scales for horizontal or vertical mounting. Models are available with zero at left, right, or center to facilitate the design of installations based on human engineering principles. All models are designed for operation with a power input of 22½ v dc at 10 ma for the switching circuit. **International Instruments Inc.**, P. O. Box 2954, New Haven 15, Conn.

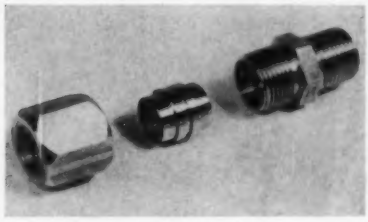
Circle 452 on Page 35



Clutch/Hub Assemblies

Ready-to-install electromagnetic clutch/hub assemblies, Cyclehub, constitute another building-block addition to a line of unitized clutches and clutch-brake machine drive components. These clutch packages incorporate a bearing supported adapter hub to facilitate mounting to a choice of special sheaves, pulleys or sprockets. They may be employed as either the driving or the driven. Open models can be obtained for either stub or through shaft mounting, while optional shrouded models, providing integrally mounted brush holder boxes and protective guard for the rotating clutch parts, are supplied for stub shaft installations only. These package assemblies are available in sizes from ½ to 20 hp with a wide selection of standard bore sizes. **Cycledynamics Inc.**, 19025 W. Davison Ave., Detroit 23, Mich.

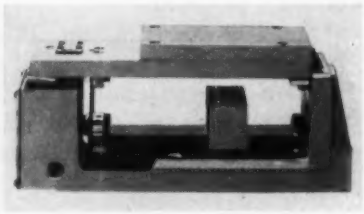
Circle 453 on Page 35



Tube Fitting

Ridg-lok tube fitting is a suitable nonflare fitting especially designed for corrosion resistant service. All three parts of the unit are machined from type 316 stainless steel barstock or forgings, making it compatible with any fluid for which this type of steel tubing is used. The fitting can be used also with Parker-Pol (polyethylene), nylon, and other plastic tubing. Size range is 2 through 16; for tubing of ⅛ through 1-inch O.D. **Parker-Fittings & Hose Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio.

Circle 454 on Page 35



Force Transducer

Instrument automatically senses and measures varying amplitude forces (tension, pressure, weight, thrust, etc.) for control purposes. Design feature of this mechanical-to-electrical transducer is a system of cross-spring (flexure) pivots com-

PDC
"AUTOMATIC"
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60"
72"
84"
96"
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Circle 708 on Page 35

What do you want to control? The flow and measure of 20,000 amperes in an aluminum ore processing plant? (A large static control system will provide pinpoint control—and eliminate the need for direct connections between meter panel and bus bar.) Or do you want to supply exact change in an automatic bill-changer? (A small static control system will do this—and detect counterfeits to boot!) Large system or small, static control can be the answer. ■ We show large and small hysteresis loops ⎍ to define these systems as *magnetic* static control. Such systems have no moving parts (static), and under normal operating conditions will never burn out or wear out. There is virtually no maintenance needed, almost no heat loss, and fewer components than in conventional systems. Static control systems are used on automobile assembly lines, for annunciator systems, and for controlling the speed of 1/20-hp motors. If you, too, would like to learn what your operating statistics and costs could be by using magnetic static control, write to Magnetics Inc., Dept. **A-87,** Butler, Pa.

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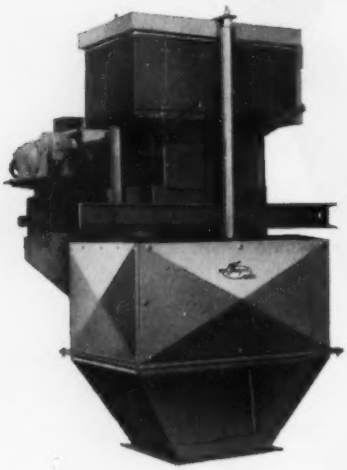
MAGNETICS inc.®

STOP PROFIT GIVE-AWAY



stay competitive with accurate Thayer scales

For 11 years a Florida fertilizer plant has kept costs down and profits up with 1 Thayer Scale. The Florida plant remains a keen competitor because of accurate weight control, low overhead and greater dollar return on its investment.

The Thayer Scale has required no maintenance and continues to give "new scale" accuracy in spite of millions of weighings of abrasive rock dusts.

Unlike conventional scales, the Thayer Scale has no knife edge pivots to wear and cause inaccurate weighing. The Flexure-Plate suspension system of the Thayer Scale cannot wear, requires no maintenance, and accuracy is guaranteed for millions of weighings.

Call or write Thayer Scale for recommendations on improving or maintaining your competitive position through precise weight control.

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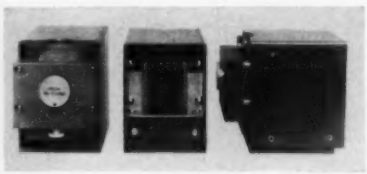
Circle 709 on Page 35

bined with a flat cantilever main spring. The flexure pivots prevent any movement of the load platform in crosswise or lengthwise planes, but allow flexure or bending in a third plane. The heavy flat cantilever spring and the flexure pivots permit direct mounting of load on the transducer. Standard models can handle loads varying from 8 oz to 1500-lb. Special designs are available for loads up to 50,000 lb. Overloading will not damage the unit or cause a shift in calibration. **Force Transducer Sales Div., Hydro-Pneu-Tronics Inc.**, 3666 E. 116th St., Cleveland 5, Ohio.

Circle 455 on Page 35



Punched Card Switch

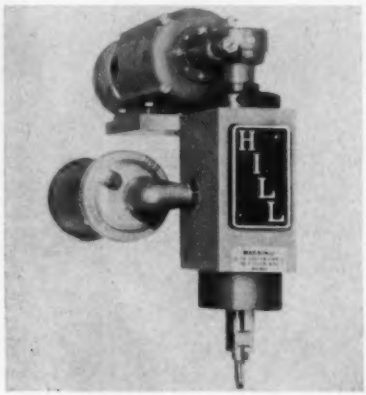
Capacity of this multiple punched card switch is 72 switches, a separate switch for each hole position. After a card is inserted and a Push-to-Close button is pushed, punched holes have closed switches, unpunched holes have open switches. Each side of each switch is isolated and tapered to accept Taper Tab receptacles. Unit weighs 3 lb 3 oz and measures 3 5/16 inches wide by 5 inches deep by 4½ inches high. It is both compact and lightweight for a wide range of applications. **Taurus Corp.**, 8 Coryell St., Lambertville, N. J.

Circle 456 on Page 35

Air-Operated Valves

Compact, light weight air operator has been developed for use with ⅛, ¼, ⅜, and 9/16-inch tubing valves. Built for pressures up to 5000 psi, these valves are available in both air-to-open and air-to-close designs. They are very useful in systems where space is limited. Principal uses are in systems requiring remote on-off operation and in relief-valve systems. **Autoclave Engineers Inc.**, 2958 W. 22nd St., Erie, Pa.

Circle 457 on Page 35



Riveter Head

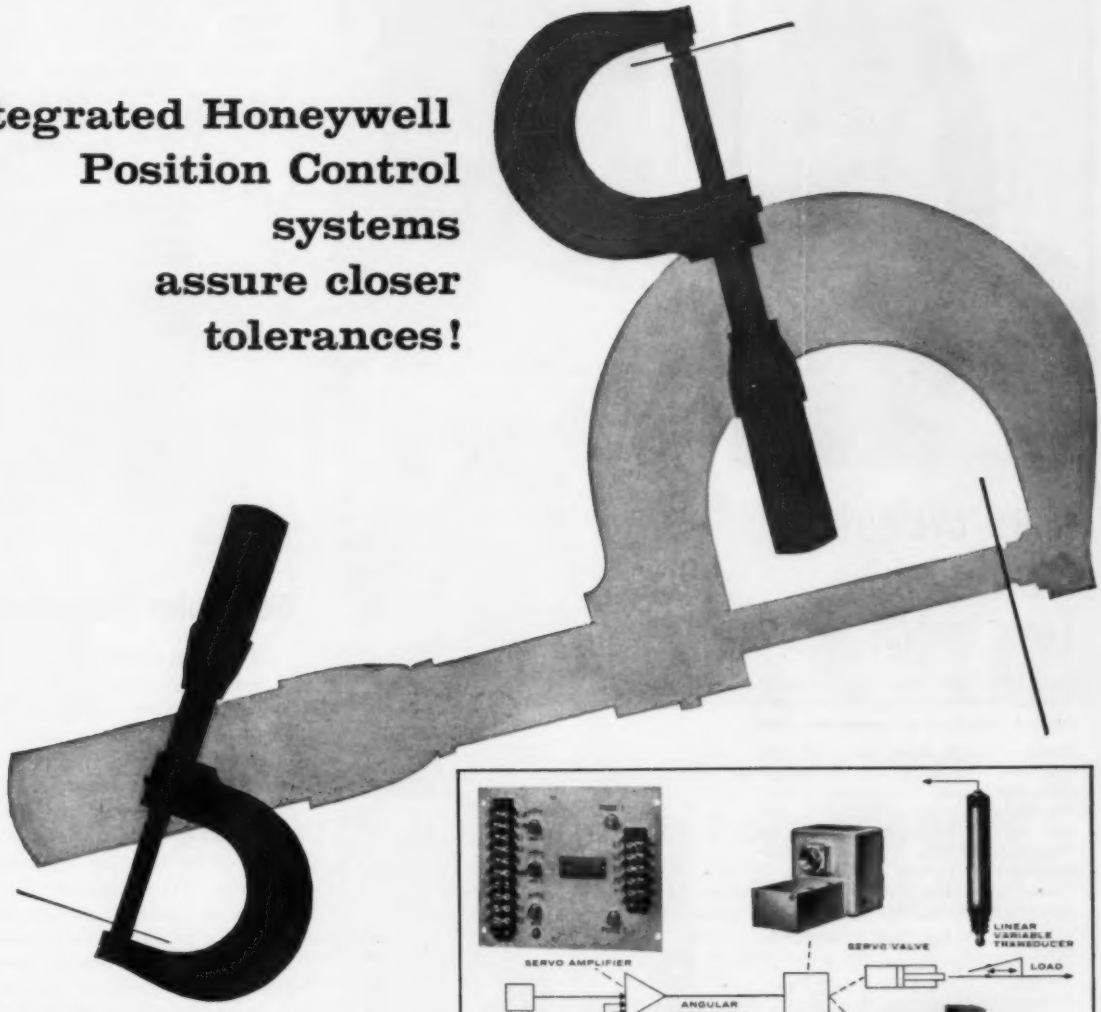
Available as a separate unit, spin-impact, peining type riveter head can be easily mounted vertically, horizontally, or at an angle (but not inverted) on a column, pedestal, or panel, or made part of a special-purpose machine tool assembly. Several heads, if desired, can be combined on one machine in various arrangements, and operated separately or simultaneously. A small motor rotates the air-operated piston, resulting in a rapid succession of peining blows by the rotating tool. Optional accessories include an air regulator, solenoid valve, and synchronous timer control. Head has solved many difficult riveting problems, particularly those involving fragile parts. **Hill Machine Co.**, Rockford, Ill.

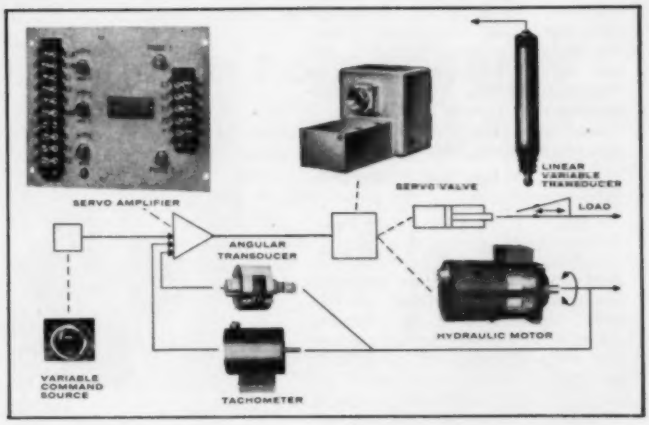
Circle 458 on Page 35

Analog Converter

Analog to digital converter is designed specially for on-line digital telemetering and control applications. Operating directly from process transducers, the Digi-Tel provides coded output for direct digital

Integrated Honeywell Position Control systems assure closer tolerances!





Honeywell "building-block" servo components can be field adjusted to assure close repeatable tolerances for industrial process control.

Now you can achieve and maintain closer tolerances for your industrial mechanisms. Even under conditions of high force and fast-stroking rates, Honeywell components assure positive, accurate servo positioning, uninterrupted processing and improved handling of materials.

System performance is the result of: (1) combining the sensitivity and high resolution of electronics with the fast response, tight actuation and variable power of hydraulics; (2) integrating components, controls and servo accessories in "building block" sequence for versatility and repeatable accuracy; and (3) designing fully transistorized components which incorporate built-in electrical feedbacks and the same high resolution and versatility of Honeywell Servo valves.

For details on any or all of Honeywell's Position Control systems, call your nearest Honeywell office; or write Honeywell, Dept. AO-6-135, Minneapolis 8, Minnesota.

Honeywell

First in Control

SINCE 1885

HONEYWELL INTERNATIONAL
Sales and service offices in all principal cities of the world. Manufacturing in the United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

Circle 710 on Page 35

More cycles! No stretch! Less punch wear!

New "Peerless" Fibre control tape wears 30 times longer than paper; costs 1/6th that of polyester film!

Need a tough tape that will take machine shop handling? A durable tape for repeat operations? Check the savings in new "Peerless" control tape. It's made of National Vulcanized Fibre, a cellulose plastic—the only tape of its kind!

Compare "Peerless" tape's long, cost-cutting cycle life:

Speed (CODES PER MINUTE)	Paper Tape (CYCLES)	"Peerless" (CYCLES)
1200	100 to 115	3,000 & over
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And check "Peerless" tape's amazing properties! It's extra tough, flexible, with high tensile and bending strength. It has high opacity, excellent abrasion resistance and is easily punched. Thicknesses: .0043" and .005"—heavier thicknesses available.

"Peerless" does not stretch in use. Precision-punched holes remain true. In addition, "Peerless" is *plastic-smooth* and impurity-free; friction and wear on punching and feeding equipment are cut to the minimum.

"Peerless" tape is available in any width. It is already proving its superior economies in tape life and cost on major automatic programming equipment in industry, government and business. Colors: Red, Gray, Blue, Black. Investigate now. Write for Free test sample and complete information. Dept. UU-6.

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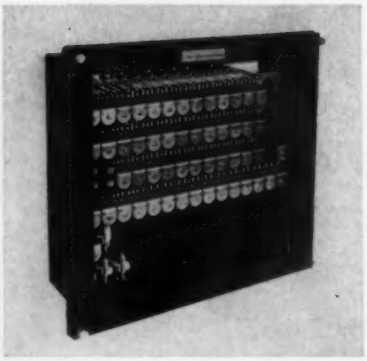
Circle 711 on Page 35



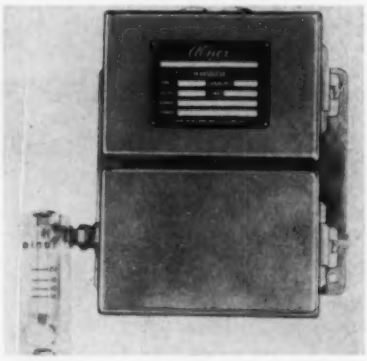
transmission, display, control, and data logging. Input transducers are available for operation from pressure, differential pressure, temperature, instrument air, and other standard variables. Output may be decimal, binary coded decimal, or specially coded to suit various requirements. Converter may be employed in any operation that can be represented electrically. **Electronetics Div., North Electric Co.,** Galion, Ohio.

Circle 459 on Page 35

Air Regulator

Quick-adjusting compressed air regulator has a lever and coarse adjusting screw in place of standard fine thread and tee-handle type adjustment screw. A 180-degree turn of the lever adjusts the regulator from 0 to 60 psi. A 360-degree turn adjusts it from 0 to 125 psi. Maximum primary (inlet) pressure is 300 psi and maximum secondary (outlet) pressure of standard unit is 125 psi. A typical application would be on an installation where a cylinder is to be cycled at low pressure one time and at high pressure another time. Model 2016 has two gage ports or 3 outlets, is self-relieving or nonrelieving, has balanced valve construction, and a nylon reinforced diaphragm. **Wilkerson Corp.,** 1552 W. Girard Ave., Englewood, Colo.

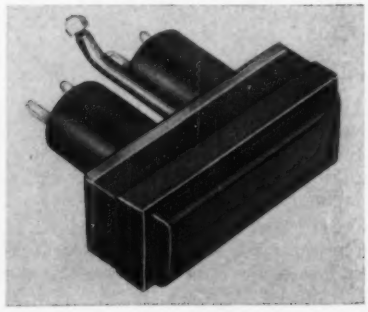
Circle 460 on Page 35



Dew Point Transducer

Developed to measure dew points in ranges of from −20 to +60F, Model 7600 dew point transducer is particularly suited for outlet measurement of endothermic gas generators used in controlled atmosphere heat treating. Continuous monitoring of the dew point is achieved by establishing a continuous flow of gas through the transducer. A millivolt output provides a choice of indicating, recording, controlling, or alarm readouts. Platinum resistance thermometer elements are interchangeable. **Alnor Instrument Co.,** 420 N. LaSalle St., Chicago 10, Ill.

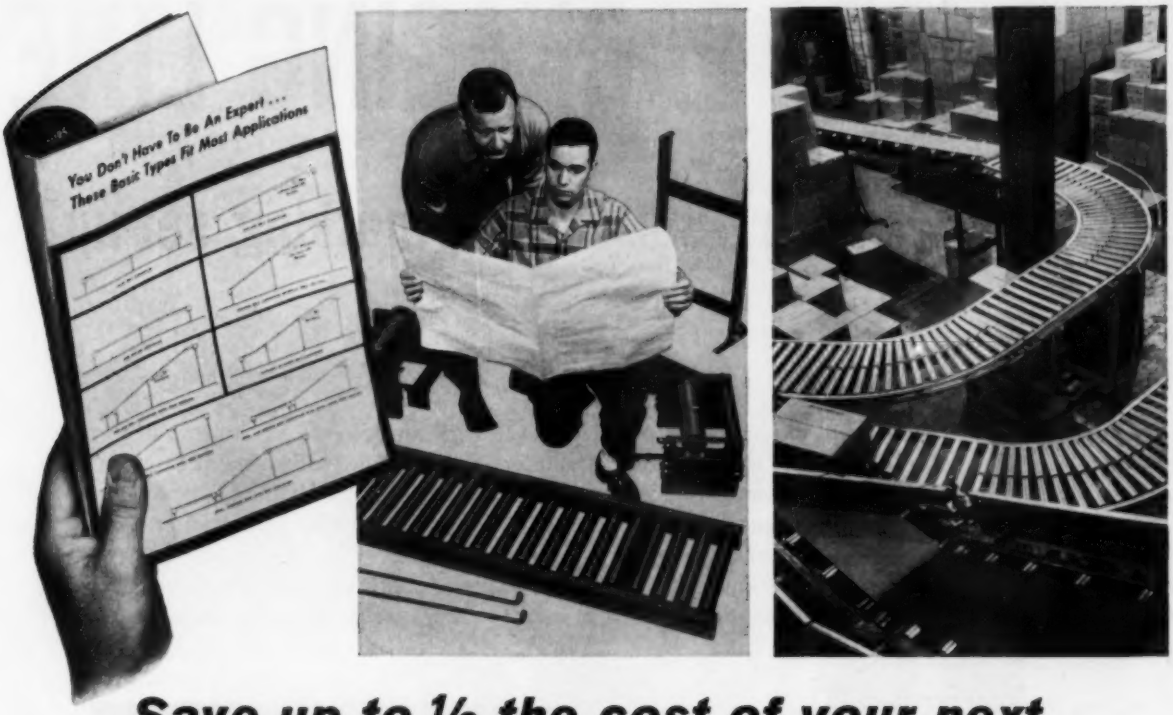
Circle 461 on Page 35



Indicator Light

Developed for control console as well as aircraft application, Model 5950 indicator light features compact

Read this... Order this... Install this...



Save up to ⅓ the cost of your next conveyor with Handidrive components

Why pay big premiums for unnecessary custom engineering? Order your next conveyor mail order style . . . right out of STANDARD CONVEYOR'S new *Handidrive* Handbook. Get fast delivery right off the shelf . . . save up to ⅓ the usual cost.

How? Using this valuable new Handbook, you can plan your own installation, order the components you need from factory stock, and then assemble them yourself with simple tools to save on erection costs. And, should you need help, our conveyor specialist in your city will be happy to give free advice on layout, ordering, prices and installation.

In-stock *Handidrive* components include gravity and power roller sections, belt sections, drive units, curves, supports, hangers, tapered sections, guardrails, feed sections, diverters —everything you normally need for an efficient, low-cost conveyor installation.

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Here's the Handbook *that tells you exactly what to do to cut costs with pre-engineered HANDIDRIVE conveyors. Send for your free personal copy now. Just fill in the coupon, attach to your letterhead and mail. Do it today!*

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YOUR NAME_____

YOUR TITLE_____

Circle 712 on Page 35

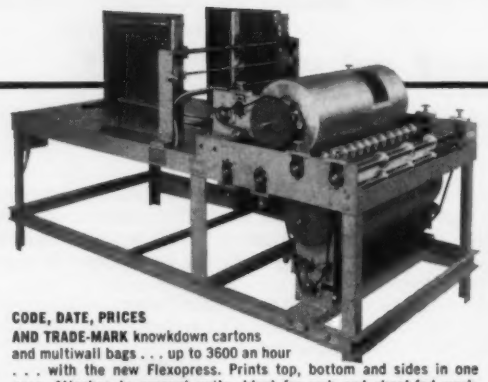
Do you have a

1961 PACKAGING LINE

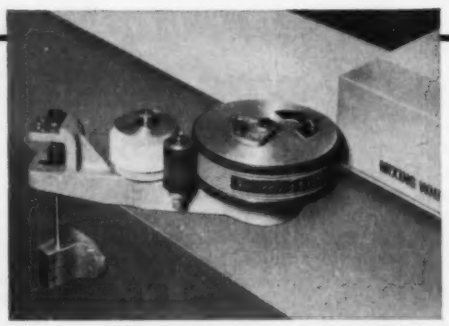
with an 1890 marking set-up?

Don't shackle your packaging line with an obsolete marking system. Look into the four IME imprinters on this page. All four synchronize to the speed of the line. All work smoothly, print distinctly, save you and customers time and bother. All offer heavy-duty construction for first-rate performance.

1961 packaging demands 1961 marking: IME marking. Performance guaranteed. For detailed, illustrated brochure write today. Dept. A

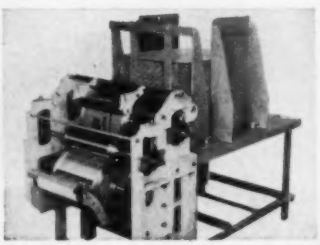


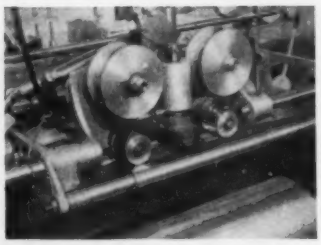
CODE, DATE, PRICES AND TRADE-MARK knowkdown cartons and multiwall bags . . . up to 3600 an hour . . . with the new Flexopress. Prints top, bottom and sides in one pass. Attaches to present units. Ideal for web and sheet-fed work, handling webs 1½" to 100" wide. Open-fountain inking system. Removable plate cylinders for off-press registration. Available in self-contained or "attachment" models.



PRINTS boxes, cartons and containers at production-line speed, whatever that speed may be. The Whippet® conveyor-line marker will mark all that passes it . . . easily adapted for top or side marking, too. Interchangeable type. Easy to maintain.

MARKS UP TO 3000 PER HOUR CARTONS AND BAGS AUTOMATICALLY: the #7 Autoprinter® Prints well on nearly every flat, absorbent surface, does one or both sides in one pass. Ink dries fast, doesn't cake . . . no need to clean rollers after use.





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BROOKLYN 8, N. Y.

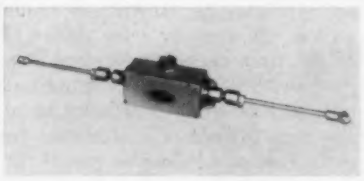
size (1.124 inches by 0.312 inch); legend readable only when indicator is lit; legend engraved on inside of lens; lens available in four different colors; lamps replaceable from front of panel. Indicator is rated at 0.04 amp at 28 v, 0.08 amp at 14 v, or 0.2 amp at 6 v. Two MS25237 lamps are retained in lens housing by spring contact clips. **Control Switch Div., Controls Company of America,** Delmar Drive, Folcroft, Pa.

Circle 462 on Page 35

Magnetic Amplifiers

Series of magnetic amplifiers in seven sizes from 75 to 400 hp is recommended for applications requiring high-capacity controlled dc power for variable-speed dc motor drives. Other suggested uses for the Mega-Power 1310 Series are for controlled dc power in plating, electrochemical processes, accelerator magnets, and other dc applications. Units feature compactness, long life, and little maintenance. **Electric Products Div., Vickers Inc.,** 1815 Locust St., St. Louis 3, Mo.

Circle 463 on Page 35



Limit Switch

Designed expressly for heavy industrial use, watertight, double circuit, push/pull limit switch features heavy duty eyelets on the end of

TRANSFER MACHINE BUILT BY BUHR MACHINE TOOL CO., ANN ARBOR, MICHIGAN

Automated GIANTS like this

REQUIRE STRONG HYDRAULIC *HEARTS* EVERY MINUTE OF THEIR WORKING LIFE

24 RACINE PUMPS *operate this 58 station 500-ton transfer machine*

The precisioned flow control of RACINE PUMPS assures the split-second timing and efficiency required to operate this complex Buhr Transfer Machine . . . custom-built for the completely automatic machining of 120 auto-cylinder heads hourly for a leading automotive manufacturer. Compact RACINE VALVES control feeds and reverse movements on all 323 operations performed by the machine. RACINE 4-WAY SOLENOIDS help one man operate this mechanical giant. Buhr has used RACINE PUMPS and Reservoir Units on custom-built machines for the automotive industry for over 10 years.

RACINE

Racine Hydraulics & Machinery, Inc.
RACINE, WISCONSIN
HYDRAULICS DIVISION

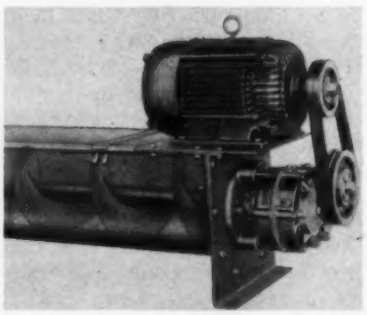
Circle 714 on Page 35

each push/pull rod for the attachment of operating cables. It is ideal for rigging safety devices and is convenient for adjusting the travel of such heavy equipment as hoists and winches. The adjustment is made by two stop collars on the operating rod. Contacts for the switch are rated for ac or dc control circuits. Ratings are 600 volts maximum ac or dc, and contacts will normally handle 10 amperes 60 cycle ac or 2 amperes noninductive load dc. A ½-inch conduit tap is standard on the 9439DW2. The switch is double limit with contacts normally closed. **Monitor Controller Div., Atlee Corp.**, 99 Grove St., Rockland, Mass.

Circle 464 on Page 35

Screw Conveyor Drive

Especially designed for short conveyor flights and low horsepower requirements, Series 100 drive is offered in two speed ratios: 8:1 for up to 6 hp at 225 rpm, and 18:1 for



up to 3.8 hp at 100 rpm. The unit consists of a double-reduction speed reducer with a packing gland and driving shaft that mounts on a trough end. It triple-seals the reducer unit against invasion by the materials being conveyed. The packing gland is adjustable from the outside, takes standard packing, and may be inspected by sight. Any desired output speed may be obtained by selecting the correct V-belt drive to transmit power from the motor. **Dodge Manufacturing Corp.**, Mishawaka, Ind.

Circle 465 on Page 35

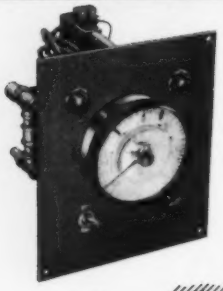
Digital Clocks

Line of digital clocks, designated Series DC-151, provide a visual display of 4, 5, 6, or 7 digits, together with contact closure outputs. Timed pulses are generated in the clock by a synchronous motor - operated switch. A mercury relay drives all of the time generating rotary stepping switches. Contact closure outputs may be either parallel or serial. Features include a pushbutton for each display window to permit independent setting of each digit, a rotary switch for external readout interval selection, and an advance inhibit which prevents any change in displayed time during a readout cycle. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif.

Circle 466 on Page 35

GAGE PAGE

A Quick Run-down of New Gaging Ideas

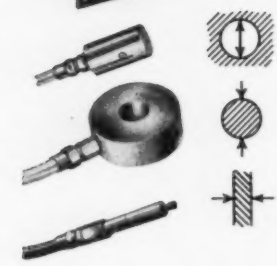


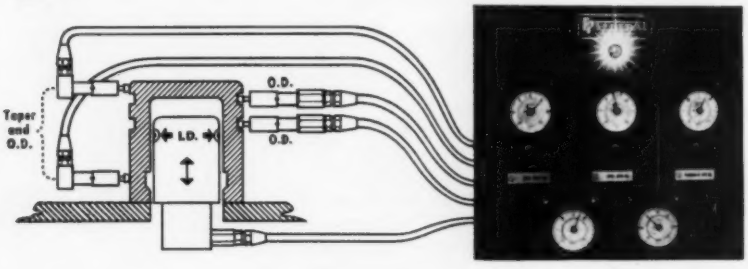
THE MOST PRACTICAL WAY

. . . to check dimensional relationships such as hole location, taper, center distance, etc., is to gage with Air.

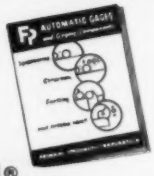
The FEDERAL Air Gaging System combined with electric control does the job rapidly . . . embraces complete selection of building-block components . . . measures inside and outside diameters, eccentricity and squareness — rapidly and economically . . . best system for otherwise inaccessible dimensions.

Cut multiple-dimension inspection time in half with Modular Unit readout . . . single master "good" light indicates at a glance all checks within tolerance . . . "over" and "under" lights for each out-of-tolerance dimension . . . individual meters for direct reading. Designed for panel mounting — each unit compact, self-contained and quickly replaceable.





For complete specs, dimensions — the *whole* story — send for Catalog 60 AM.



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1395 EDDY STREET, PROVIDENCE 1, R. I.

Ask **FEDERAL**® *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .
Dial Indicating, Air, Electric, or Electronic—for Inspecting, Measuring, Sorting, or Automation Gaging

Circle 715 on Page 35

SUPER-SPEED·SUPER-POWER

from this 2½" Bore AIR CYLINDER

Model BNSSEM-5C Super-Speed Air Motor equipped with electrically-operated valve.

This special machine designed and built in the plant of Electro-Mechanical Products Co., clamps and pierces 3 holes in 20,000 pieces per day. It uses 3 Bellows Super-Speed Air Cylinders and a Bellows Air Motor. Set-up cost ⅓ the price of a punch press die.

This Super-Speed® Bellows Air Motor® is so powerful it can drive a 1/2" hole through 1/16" thick steel. The piston rod moves at a speed six to ten times the speed of an equivalent sized air cylinder.

That's why the Super-Speed is an ideal answer to many piercing, staking, forming, riveting, stamping, swedging and similar operations.

The Super-Speed Air Motor uses the basic Bellows integral valving system with built-in operating and speed controls. Only one air connection is required which can be flexible hose. The directional valve may be either the low-voltage (8-12V) Electro-aire® Valve or the finger tip control manual valve. One bore size, 2-1/2". Four standard stroke lengths, 4", 6", 9" and 12".

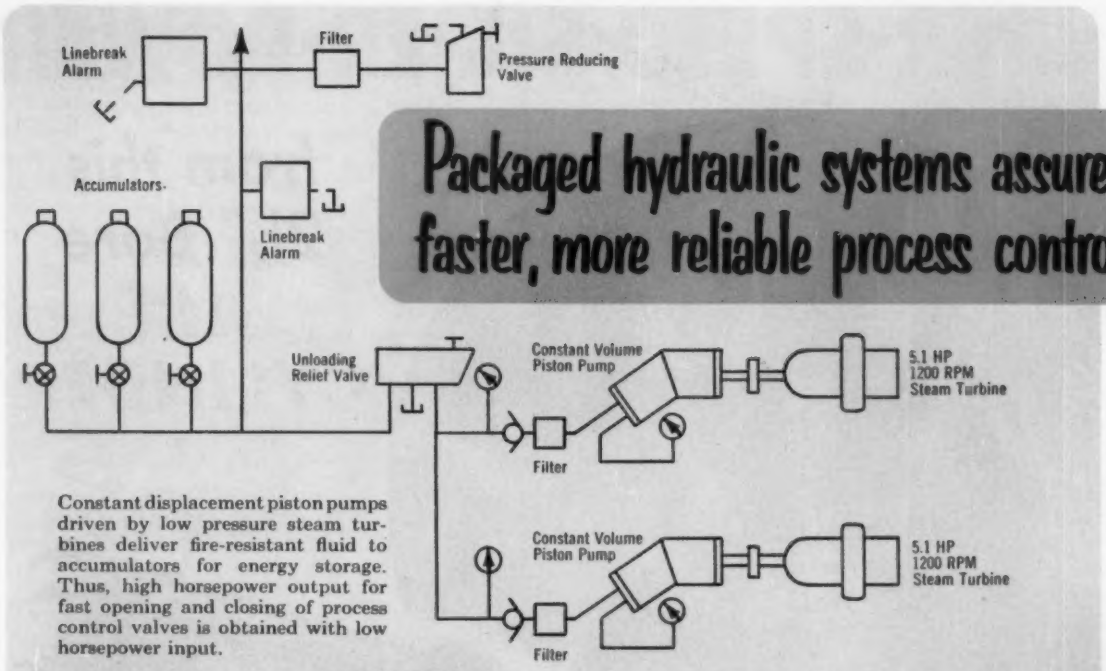
Write for Bulletin SS-5R. Address Dept. AU-661, Bellows-Valvair, Akron 9, Ohio.

More than 200 Bellows-Valvair Field Engineers are at your service

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

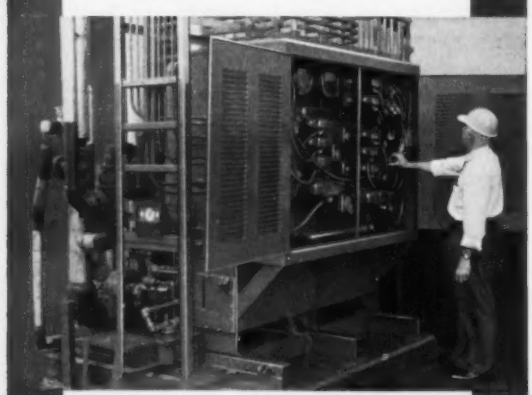
965-C

Packaged hydraulic systems assure faster, more reliable process control



Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

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ADMINISTRATIVE and ENGINEERING CENTER
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AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 35.

Automatic Lathes

Jones & Lamson Machine Co., Springfield, Vt.—3 booklets—Data are contained in these booklets regarding three model 30 automatic lathes. All of these machines have the same basic bridge-bed design. A great variety of drives, slides, tracing units and machine variations can be adapted to suit individual requirements. With these variations, three distinctive versions of the Model 30 evolve. They are Model 30-60 degree Auto Tracer; Model 30-2D (180 degree) Auto Tracer; and Model 30 Multiple Slide automatic lathe.

Circle 467 on Page 35

Metal-Cased Switches

Unimax Switch Div., W. L. Maxson Corp., Ives Rd., Wallingford, Conn.—16 page booklet—Catalog 30-1 gives details on a KL series of heavy-duty, metal-cased switches and a double-break type BK-1 switch. Listings include limit switches, safety switches, and aircraft switches. Data on bases, circuit arrangements, and NEMA standard definitions of precision snap-acting switch terms are also included as well as a helpful section on how to choose the switch best suited to a particular service requirement.

Circle 468 on Page 35

Card Reader

Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.—2 page pamphlet—Bulletin DPS-A43 describes a CR-201 card reader designed to transport IBM cards from a card hopper, past two read stations, and into a card stacker at a speed of 30 cards/minute. The cards are scanned row by row and contact closure outputs corresponding to the perforations in all 80 columns in both cards are provided. The card reader may be operated either from an integral control panel or remotely. Output signals are provided by mercury relays mounted on printed circuit cards contained within the reader.

Circle 469 on Page 35

Conveyor Muffle Furnace

Sunbeam Equipment Corp., 180-13 Mercer St., Meadville, Pa.—6 page pamphlet—Bulletin SEC-13 describes the advantages and features of a conveyor muffle furnace for continuous bright copper brazing, bright annealing, and bright hardening of stainless steel up to 2100F. Furnace features a drive and take-up system, radiation shields, cylindrical muffle, heating chamber insulation, and a specially insulated hearth. A prewired control panel is normally included with the furnace. Photographs and a schematic diagram show construction features of the device.

Circle 470 on Page 35

Point-to-Point Positioner

Industrial Div., Moog Servocontrols Inc., East Aurora, N. Y.—8 page bulletin—Data are contained in Bulletin 400 on a Hydra-Point numerical control system that is ideally suited for use on jig borers as well as for short run operations on machines such as turret drills. Standard system includes tape reader, hydraulic power supply, control console, and table positioning actuators. Metalcutting instructions stored on punched tape are converted to accurate table positions by a hydraulic device which does not involve the use of electronics.

Circle 471 on Page 35

Workholding Devices

Sutton Tool Co., Sturgis, Mich.—20 page booklet—Bulletin 70 covers a line of workholding devices. Details are provided on a Helimatic nondistorting chuck designed to facilitate machining thin wall parts. Collet type chucks and mandrels are described and illustrated. Schematic diagram illustrates construction details of a Levermatic collet chuck that employs lever and cam action. Also illustrated and described are several special tools developed to customers' specifications.

Circle 472 on Page 35

Welding Equipment

Federal Machine & Welder Co., Warren, Ohio—8 page bulletin—Data are contained in Bulletin 1-60 on the installation, starting, lubrication, and maintenance of a line of welders. Included in this line are roll spot and seam welders, air-operated projection welders with dial feeds, and three-phase spot welders. Maintenance of the vital weld transformer is discussed. Causes of imperfect welds are listed, as well as recommended electrical and mechanical spare parts.

Circle 473 on Page 35

Bulk Handling Conveyor

Prab Conveyors Inc., 30121 Groesbeck Highway, Roseville, Mich.—14 page booklet—Brochure TV-98 contains data on a totally enclosed bulk material handling conveyor featuring a two directional chain to convey in any direction. Materials handled by this conveyor vary from steel chips and ball bearings to plastic, rice, and starch. The Tube-Veyor system can be fed and discharged in as many points as desired.

Circle 474 on Page 35

Drafting Templates

Rapidesign Inc., P.O. Box 429, Burbank, Calif.—20 page booklet—Catalog 65 which is divided into eight sections covers 115 drafting templates. Twelve templates in the electrical section have symbols used in electricity and electronics. Eleven templates in the mechanical engineering field include screw threads, gears, nuts, and bolts. Lettering templates have block letters, slanted letters, modern type, and neographic type. Processing templates include those used in chemical and instrumentation fields.

Circle 475 on Page 35

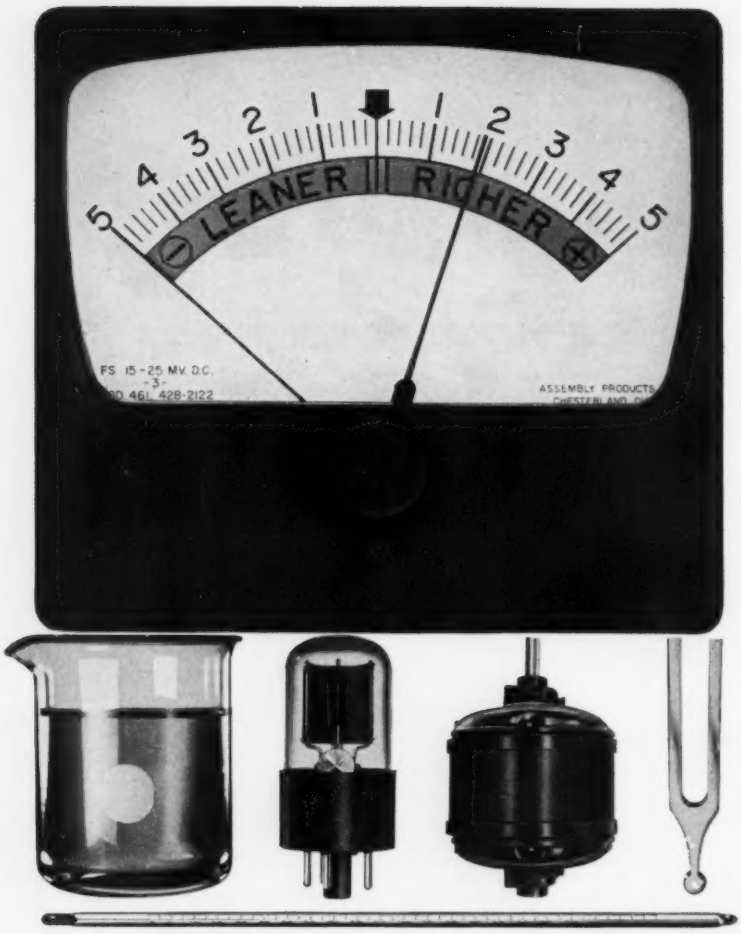
Chart Integrator

American Meter Co., Advertising Dept., 920 Payne Ave., Erie, Pa.—2 page pamphlet—Bulletin 419 provides details on a chart integrator for interpretation of a line of strip charts and conventional round charts. Integrator provides three values from a single run. It not only computes the chart extension for differential and static pressure, but also provides read-out values for the average absolute static pressure and the average differential pressure. Details are provided on how the device converts from use with strip charts to use with round charts by means of a simple adaptor plate supplied with the instrument.

Circle 476 on Page 35

Industrial Rubber Products

Manhattan Rubber Div., Raybestos-Manhattan Inc., Passaic, N. J.—22 page booklet—Catalog M5 describes a line of rubber products for industry. Included are sections on a Poly-V drive, V-belts, transmission belt, conveyor belt, and all types of hose, flexible rubber pipe and expansion joints, plus a summary of molded



WITH A. P. I. METER-RELAYS YOU CAN MONITOR AND CONTROL JUST ABOUT ANYTHING!

Handy gadget, the A.P.I. meter-relay. You can use it to indicate, monitor, and control practically any electrically transduceable variable. Things like moisture content, pH, motor load, radiation level, temperature, speed, light, sound. And, because it's so highly sensitive (0-5 microamps or millivolts is the minimum range), you can pipe-in thermocouple, strain gauge and other low-level signals directly, without amplification.

It's a highly reliable device, too. You can reasonably expect to get at least 10,000,000 perfect make-break operations. You'll probably get twice that many. We have.

You can spec A.P.I. meter-relays in any range you want, from the minimums mentioned up to 0-50 amps or 0-500 volts, AC or DC. We can calibrate scales in any units you require. Control setpoints can be either single (high or low) or double (both high and low). Catalog 4J will give you much useful and interesting information about meter-relays. It will also give you detailed, explicit specs and prices. Yours for the asking, of course.

ASSEMBLY PRODUCTS INC.
CHESTERLAND 27, OHIO

SA 2306

and extruded products. Details are provided on the design and operating advantages of such products as CX molded V-belts, length stabilized Condor V-belts, Ray-Man heavy duty conveyor belt for 45-degree idlers, hot material belts, coal mine belts, Wedlok splice that eliminates vulcanizing, and high pressure burst-proof steam hose.

Circle 477 on Page 35

Door Interlock Switches

Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—4 page pamphlet—Data Sheet 186 contains information regarding 8 standard door interlock switches used as safety devices on hazardous electronic equipment. Switches automatically cut power when a service door or drawer is opened, permitting personnel to check or repair equipment in safety. Bulletin includes three new series: The 13AC will reset without interrupting the circuit; the 8AC has four subminiature basic switches; and the 9AC has sealed subminiature basic switch. Also included are three series of door interlock switches which have thermoplastic actuating rods.

Circle 478 on Page 35

Milling Machine

Pratt & Whitney Co. Inc., Charter Oak Blvd., West Hartford 1, Conn.—8 page bulletin—Circular 642 covers an automatic tracer-controlled milling machine with electronic control, incorporating transistorized logic circuits to provide extreme sensitivity and rapid machine response. BL-3622 Model C is capable of two dimensional profiling and three dimensional full model reproduction as well as two dimensional profiling at variable depth. In each case, the tracer and cutter travel in unison. A wide range of feed rates and spindle speeds are available—from 0.30 to 30 ipm and from 40 to 3600 rpm respectively.

Circle 479 on Page 35

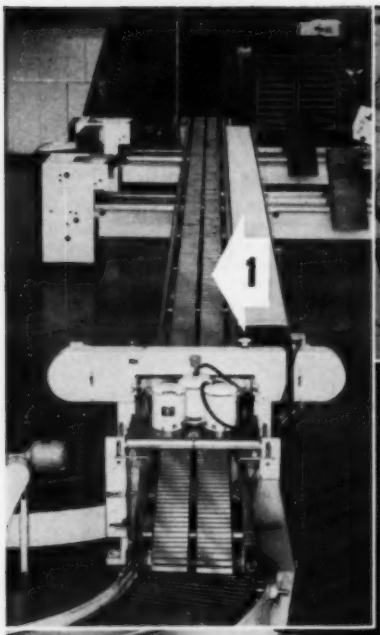
Hydraulic Relief Valves

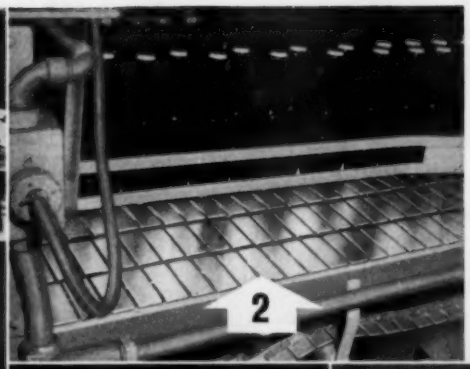
Parker-Hannifin Corp., Sales Promotion Dept., 17325 Euclid Ave., Cleveland 12, Ohio—3 catalog sheets—Pilot operated relief valves, engineered for a minimum 5-to-1 safety factor over rated operating pressure, are explained in Catalog Sheets 1540A11 and 1541A11. Line mounted type valves are for 3000 psi hydraulic systems while gasket mounted units are rated at 5000 psi. Both series are provided in rated capacities of 20 and 50 gpm. Subplates for use with the gasket-mounted type are described in catalog sheet 1541A12.

Circle 480 on Page 35

Web Shearing Lines

Stamco Inc., New Bremen, Ohio—16 page booklet—Bulletin CTL-56 contains data regarding cut-to-length lines designed to automatically shear blanks or sheets from a coil of steel. These lines are capable of shearing metals from 0.010 to 0.250 inch thick from coils weighing 500 to 20,000 lb. Coils from 12 to 72 inches wide may be sheared into blanks 12 to 180 inches long. Three sizes of lines are available which cover the entire range of sheets and light gage plates. A light duty line is for 16 gage maximum and is ideal for small blanks where accuracy is imperative. The heavy duty line has a maximum capacity of 10 gage and its greatest use is in warehouses and manu-





❶ 20 Dozen Rolls Per Minute
450 feet of *Duraweld* rush oven-fresh baked goods through Western bakery.

❷ Faster, More Efficient
Duraweld reduced downtime at Midwestern brewery.

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Duraweld speeds 2-oz. to 1-gal. containers through Resina High-Speed Screw Capper.

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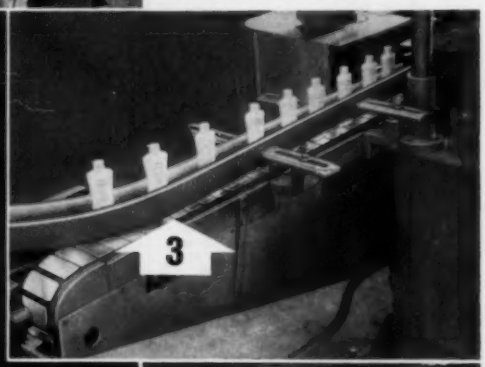
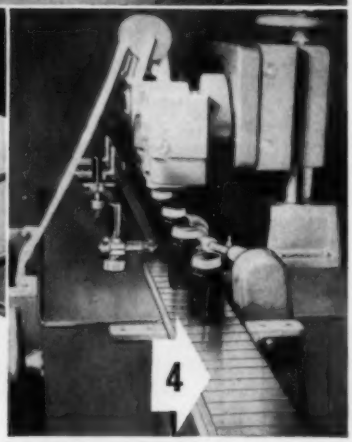
Duraweld handles vials, cans, bottles and jars on John Burton Automatic Cellubander.

from breads
to beer
to beauty
aids...





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delivers the goods to reduce processing, packaging and product handling costs!

You can reduce production costs with smooth-running, longer lasting DIAMOND *Duraweld* Conveyor Chain. *Duraweld* is all steel (stainless if you prefer) that shrugs off wear, solvents, and scalding detergents. Streamlined design permits higher operating speeds and loads with less maintenance and downtime.

Duraweld top plates are welded to roller chain linkplates to reduce weight and cost; permit the use of wider support rails that improve top plate load capacity and load distribution. This, plus deep sprocket engagement, insures smooth high speed operation.

For complete information, call your DIAMOND Distributor or write direct to DIAMOND CHAIN COMPANY, INC., *A Subsidiary of American Steel Foundries*, Dept. No. 412, 402 Kentucky Avenue, Indianapolis 7, Indiana.

DIAMOND ROLLER CHAINS ®

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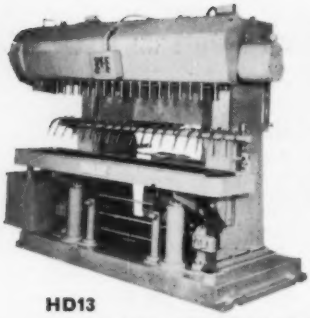
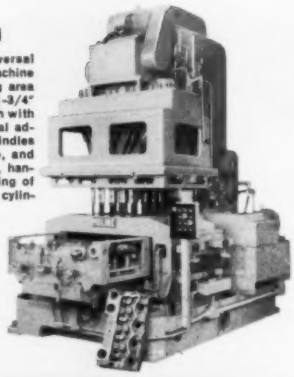


MODEL HU111

Hydraulic Feed, Universal Joint-Type Drilling Machine with 24" x 50" drilling area and with forty-two 1-3/4" spindle drivers, each with two-speed and neutral adjustment. Thirty-six spindles in slip spindle plate, and power shifting fixture, handle drilling and reaming of three different engine cylinder heads.



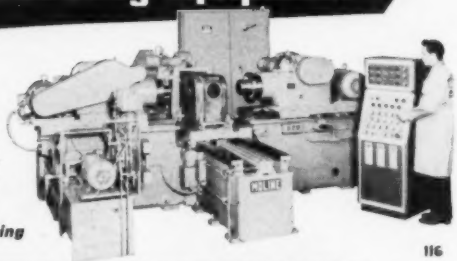
HD13

straight line drilling machine with hydraulic table feed and 18 spindles each having 11/16" diameter drill capacity in mild steel. Spindle center distances are adjustable along the 6-foot machine rail.

MOLINE Cost Reducing Equipment

MODEL MR148

Three-way, three-spindle, horizontal boring machine with selective automatic feed cycle. Handles boring of cylinder and crank bore for 3 sizes of 1-cylinder blocks. Also bores for wet sleeves in 2- and 3-cylinder blocks.



60 years of Machine Tool Engineering Experience is at your service for 116

- Multi-Spindle Boring • Single and Multi-Spindle Honing
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- Special Multiple Operation Machine Tools

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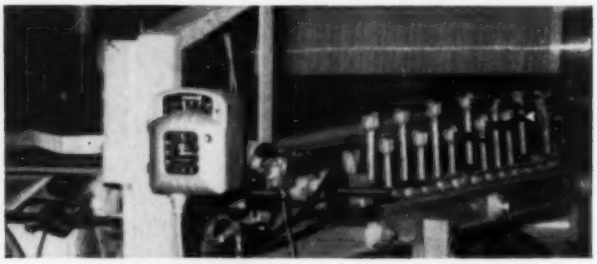
REPRESENTATIVES IN PRINCIPAL CITIES

Circle 719 on Page 35



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A WAGNER® INDUSTRIAL RECORDING SYSTEM
records slasher production

Burlington Mills uses an Industrial Tachograph to measure the production efficiency of this slasher. The Tachograph is a precision recording device that lets you measure output versus time. It can be used wherever the control of speed, time and measurement is essential to the quality of your products.

Tachographs graphically record operation of one machine or an entire line...aid in quality control and time study programs ...help you determine production peaks and valleys, and nonproductive time. Chances are, Tachographs can help increase your mill's efficiency. Mail coupon below for full information.

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Please send a copy of Bulletin SU-144.

Name_____
Company_____
Address_____
City & State_____
Proposed Application_____

W161-1

Circle 720 on Page 35

facturing plants for making sheets and large blanks. Mill duty line ranges up to approximately 0.250 inch maximum gage, and is specially engineered for the requirements.

Circle 481 on Page 35

Multipoint Controllers

Thermo Electric Co. Inc., Saddle Brook, N. J.—8 page bulletin—Instrument Section 52 contains details regarding an electronic multipoint controller for accurate, automatic, two-position control of up to 10 industrial processes; three position control of 5 processes; constant control of a single process; manual balance indication of exact process conditions at each point controlled and for monitoring. Photographs illustrate the instrument controlling various machines or processes, describe components, and demonstrate maintenance and installation.

Circle 482 on Page 35

Barrel Finishing Processes

Norton Co., Advertising Dept., Worcester 6, Mass.—96 page handbook—Form 501 includes descriptions of various barrel finishing processes, recommendations of various abrasive shapes and sizes for applications in which they are best suited, case histories of actual uses, descriptions of finishing equipment available, and a discussion on compounds and their effects. A section is devoted to practical suggestions on operating procedures.

Circle 483 on Page 35

Overhead Handling Systems

Cleveland Tramrail Div., Cleveland Crane & Engineering Co., 1036 East 289th St., Wickliffe, Ohio—12 page booklet—Booklet 2008-Q provides data regarding a line of overhead materials handling equipment. Various types of carriers, cranes, tractors, track switches, grabs, and electrification methods are described. Detailed studies of track design and stresses are given. Photographs illustrate typical installations.

Circle 484 on Page 35

Fluid Power Applications

Oilgear Co., 1571A W. Pierce St., Milwaukee 4, Wis.—4 page pamphlet—Fluid Power News 15 outlines four fluid power case histories. These case histories include: Direct chill billet casting production in large aluminum plants, roll life on holddown and lift systems on paper machines, speed synchronization between numerous sections of a paper machine, and steering gear dependability and characteristics on a variety of vessel types.

Circle 485 on Page 35

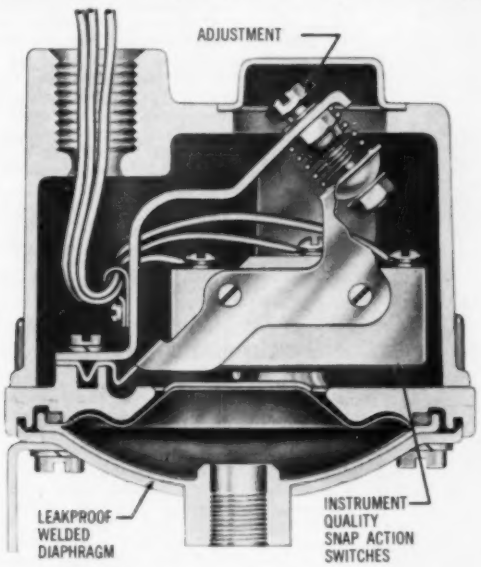
Strapping Machines

Signode Steel Strapping Co., 2600 N. Western Ave., Chicago 47, Illinois—4 page pamphlet—Specifications of 14 models of a line of compression strapping machines are detailed and compared in this folder. Compression equipment increases product protection by restricting slippage within the pack; powered strap feed makes high-speed strapping a one-man operation. Pneumatic as well as hydraulic press models are described. They offer maximum

BREAKTHROUGH IN PRESSURE SWITCH ACCURACY

at reduced prices

The high accuracy associated with instruments costing several hundred dollars is now obtainable with new Barksdale pressure switches at a retail cost of $19.00 to $30.00. Accuracy of ±0.5% is guaranteed and ±0.2% accuracy can be supplied when required. Substantial price reduction is accomplished by use of erector set design and a major investment in production tooling. A wide choice of "tailored to the job" features (see column at right) meets your specification requirements exactly.



THESE POINTS ARE IMPORTANT

WE BUILD IN	WE DON'T USE
EXTREME ACCURACY and DEPENDABILITY maintained during operating life due to direct acting design	LINKAGES & BEARINGS which, as they wear, make the setting of the pressure switch drift.
OPERATION IN ANY POSITION which saves the installation costs encountered in mounting a switch that uses liquid switching elements	LIQUID SWITCHING ELEMENTS which make the switch difficult to mount and very critical to vibration.
IMMUNITY TO VIBRATION you can mount the switch directly on your vibrating or moving equipment.	ACCORDION BELLOWS which make the pressure switch sensitive to vibration.

PRESSURE SWITCH DIVISION

Barksdale valves

5125 Alcoa Avenue, Los Angeles 58, California

New line of Barksdale pressure switches announced

Improved accuracy, reduced cost and higher proof pressures are advantages made possible by design innovations in the new Barksdale diaphragm pressure switches. Accuracy of ±0.5% as compared to the customary ±1.0% is guaranteed, and each unit is tested for repeat accuracy of set point and re-set point before shipment. Accuracies of ±0.2% are available on request.

Erector set design offers dual benefit

The basic unit of all Barksdale diaphragm pressure switches is a diaphragm surrounded by a heavy protective capsule to which components may be attached as required. Addition of a switch, switch bracket and adjusting bracket to the basic unit makes a stripped switch for use in a common cabinet with other electrical devices. (Original equipment manufacturers need not pay for a housing which is not needed.) Addition of a sealed housing to the stripped switch completes a weather- and vapor-tight switch unit. A standard housing with integral terminal block or an explosion proof housing with integral terminal block may be specified. Erector set construction allows a wide choice in specifications that approximates a custom made switch and permits use of cost-cutting mass production methods that are reflected in lower prices.

Proof pressures to 600 psi

In the low settings the new Barksdale pressure switches will actuate at 0.1" mercury with proof pressure to 10 psi. In higher ranges they will go up to 600 psi proof pressure at settings to 400 psi. This makes it possible to use inexpensive diaphragm pressure switches on installations that presently require higher priced bourdon tube switches.

Important additional advantages

Because the housings of Barksdale pressure switches are independent of the sensing and switching mechanisms changes in ambient temperature will not throw these switches out of adjustment.

The adjustment brackets are specially designed to protect switch terminals against shorting during adjustment.

Lead wires are held down by a tension clip. They cannot be pulled out accidently and thereby throw off the switch adjustment.

Mounting brackets may be oriented in any of four directions.

Tamper proof adjustment covers have servicing instructions on the inside to allow for painting of the units.

Standard pressure connection is ¼" n.p.t. female pipe fitting. One-half inch fittings suitable for mounting directly on ½" pipe can be supplied on request.

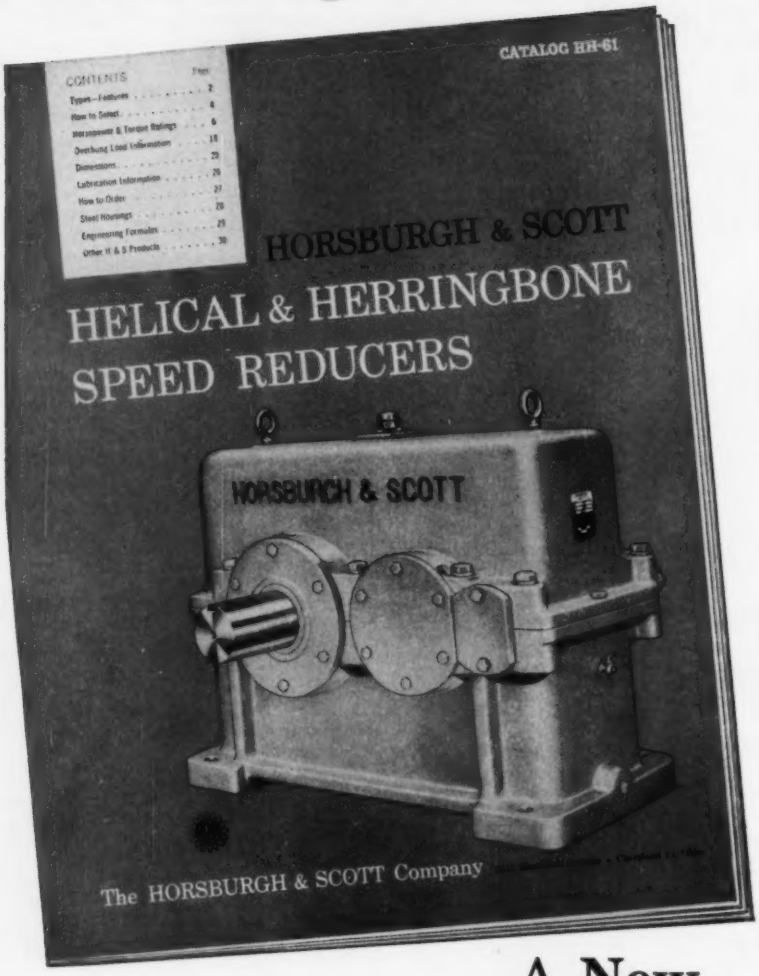
Standard housing has ½" nps conduit connections and a terminal block. The latter is accessible without removing the housing by lifting a cover plate.

Ask for new catalog and handbook

Complete details on Barksdale diaphragm, piston and bourdon tube pressure switches are included in a new catalog and handbook. This free book is a practical aid in planning the vital link between your electric and hydraulic circuits. It contains a glossary of terms, a schematic demonstration of operating characteristics, and a suggested step-by-step procedure for simplifying pressure switch selection. In addition, the book gives a complete run-down on all the detail features leading to the unit that answers your specific control problems. Send for your copy now, or ask your Barksdale representative.

Circle 721 on Page 35

Introducing . . .



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HORSBURGH & SCOTT
SPEED REDUCER CATALOG

To Simplify Selection of Speed Reducers for Industry

New catalog features include:

New Sizes • Improved Ratings • More Ratios • Latest AGMA Thermal Ratings • Simplified Selection • Easy-to-use Overhung Load Ratings • Steel Housings.

Write for **Catalog HH-61**—on your company letterhead, please.

Let our engineering staff give you prompt assistance with your enclosed gearing requirements.

H&S

The HORSBURGH & SCOTT Co.
5112 Hamilton Avenue • Cleveland 14, Ohio

platen pressures from 6000 to 20,000 lb. Pneumatic models offer 6000 lb pressure on as little as 50 psi line air pressure. Products for which various models have been specifically designed, including textiles, KD containers, multiwall bags, and paper, are listed.

Circle 486 on Page 35

Integrated Data Processing

Friden Inc., 421 University Ave., Rochester 7, N. Y.—28 page catalog—Catalog SP-8604-R4-ROCH contains data regarding a line of integrated data processing equipment. Described and illustrated are a number of systems applications which show how data are stored in coded punched tape form that is self-perpetuating. In operation, source documents are written on a Flexowriter typewriter which punches a tape as a byproduct of the typing operation and reads tape for automatic operation of its own typing unit or other processing machines. System applications include such uses as automatic letter writing; preparation of purchase orders, materials requisitions, and checks; and typing of duplicate masters for production scheduling.

Circle 487 on Page 35

Synchros and Resolvers

Theta Instrument Corp., 520 Victor St., Saddle Brook, N. J.—32 page handbook—Handbook contains a technical discussion of the electrical characteristics of synchros and resolvers. It describes in detail the application and significance of such parameters as electrical error, electrical zero, fundamental null, total null, transformation ratio, and phase shift. When synchros and resolvers are used in systems, each of the data-sheet properties undergoes drastic change; the nature of which is thoroughly explained. Methods of measurement and basic specifications for test equipment are also included.

Circle 488 on Page 35

Cold Forming Process

Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.—8 page bulletin—Bulletin RF-60 describes and illustrates a Roto-Flo process of chipless machining for cold-forming splines, serrations, grooves, threads, and similar forms. Detailed illustrations show the process in operation and the types of work performed. Illustrated are ways of obtaining increased output, material savings, finer surface finish, stronger parts, longer fatigue life, longer tool life, and reduced secondary operations.

Circle 489 on Page 35

Gear Motors

U. S. Electrical Motors Inc., P. O. Box 2058 Terminal Annex, Los Angeles 54, Calif.—6 page pamphlet—Brochure F-1971 contains technical data, feature illustrations, and descriptions for a line of right-angle worm gear motors. Ratings and dimensional data for Syncrogear units are given both for single reduction Type GW and double reduction Type GWB. Speeds of 3.25 to 230 rpm (positive speed reduction provides standard AGMA output speeds) and gear ratios up to 87:1 are shown for Type GW, and ratios up to 354:1 for Type GWB. Horsepower ratings are 1/3, ½, ¾, 1, 1½, and 2 hp. A number of specialized models such as totally

RAPISTAN Ideas HANDLING

STEP-BY-STEP ANALYSIS

can cut your handling problems down to size

As with most engineering problems, those involving materials handling often seem less formidable when they are dissected and examined as smaller units of the overall flow system.

Materials handling engineers refer to this principle as "disassociation of inter-related operations"—and, for all its imposing sound, Rapistan sales engineers apply it effectively to analyze a handling problem and arrive at the most practical and economical solution.

When analyzed in this light, any flow pattern can be reduced to a series of identifiable units of movement, interspersed with related periods of storage. To effect the changes from "go" to "stop" and back to "go" again, a number of mechanical or manual transfers must be provided for. Then, all these inter-related steps must be controlled—unified into a coordinated flow system.

In this plant, live storage Flow Rack at the receiving area holds a reserve supply of many materials ultimately destined for storage at the point of use, to accumulate a full payload for fork truck deliveries to work stations. Notice the unique side-loading device on the lift truck, designed for efficient loading and unloading of hatches in the Flow Rack. Live storage also simplifies inspection, paper work, etc. at receiving department.

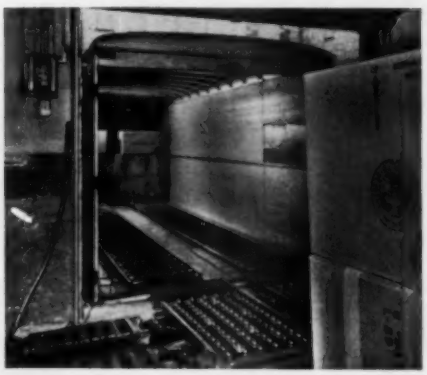
When properly "disassociated", operations that may have been considered as units frequently are found to consist of a number of steps. For example, receiving goods into storage may in reality involve 6 or 8 individual units of movement, transfer and storage.

By treating each of these units as an independently solvable problem, within the framework of the overall flow system, Rapistan handling engineers can recommend the method and equipment that will best mechanize each operation, and best coordinate with preceding and subsequent operations.

This large furniture plant has "disassociated" its receiving operations from production operations. In-coming materials are unloaded directly to platform trucks or pallets by truck drivers. Inspection and receiving forms are completed by company personnel when most convenient.

In analyzing thousands of handling problems, Rapistan engineers have found that the vast majority are closely linked to the storage of goods for long or short periods of time. Improvements in accumulation methods, therefore, promise important economies in equipment, time and manpower for materials handling. This is the area of industrial "warehousing" in which Rapistan engineers have amassed a wealth of practical experience and knowledge.

If you'd like to see some practical suggestions to solve your handling problems based on these principles, call your Rapistan sales engineer. Or, write directly to The RAPIDS-STANDARD CO., Inc., 554 Rapistan Bldg., Grand Rapids 2, Michigan, for our "Handbook of Materials-Handling Ideas".



"Disassociation" works in truck loading as well as unloading. Pallet-loads of shipping cases are accumulated on floor-mounted gravity roller conveyor Company trailers are equipped with matching roller conveyor lines, can be completely loaded in less than a minute, in a single operation.

Rapistan®

CONVEYING EQUIPMENT

Circle 723 on Page 35

Will a

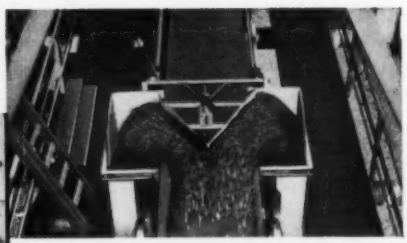
SANDVIK STEEL BELT CONVEYOR

Improve YOUR Kind Of Automation?

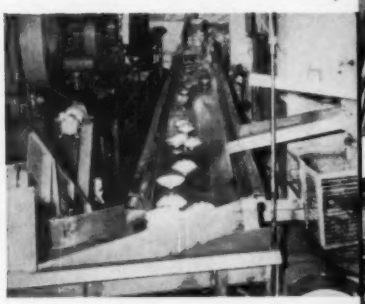
IT WILL, IF THESE ADVANTAGES ARE IMPORTANT TO YOU.

- *A strong, impermeable conveying surface of solid steel that —*
- *Resists oil, heat, impact and abrasion*
- *Lets products ride or slide, simplifying live backlogging and automatic discharge.*

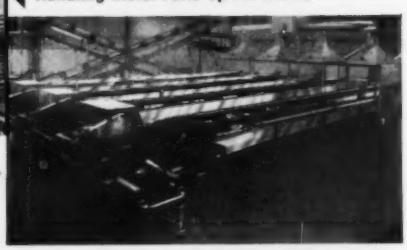
For more information without obligation write or phone your nearest Sandvik office.



Handling Bulk Materials



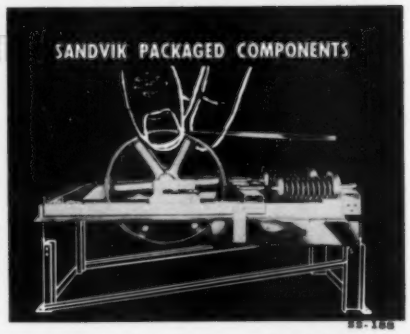
Handling Metal Parts Up An Incline



Sandvik Water-Bed Conveyors Cooling & Solidifying Chemicals

You Can Buy It Complete Or Build It Yourself With

In addition to complete, custom-engineered steel belt conveyors, Sandvik supplies conveyor components in packaged unit assemblies. For example, from Sandvik you can buy the tension end assembly, drive end assembly, steel belt, idlers and discharge devices and Sandvik will provide engineering assistance to help you build or convert to a steel belt conveyor.



SANDVIK STEEL, INC.

SANDVIK STEEL BELT CONVEYORS

Steel Belt Conveyor Department
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Sandvik Canadian Ltd., P. O. Drawer 1335, Station O. Montreal 9, P. Q.

Manufacturers of Steel Belt Conveyors for Over 40 Years.

Circle 724 on Page 35

enclosed, explosionproof, flange-mounted, single phase, and variable speed, are shown.

Circle 490 on Page 35

Sorting Conveyor

Speaker Sortation Systems Inc., 4535 N. 128th St., Butler, Wis.—4 page pamphlet—Bulletin 10-59 HA contains data on an automatic sorting conveyor suitable for use in such areas as parts warehouses, manufacturing assembly systems, mail order houses, transportation terminals, and parcel-handling and delivery services. This system can be coupled with an electronic computer, and can sort packages into orders at the rate of one per second or faster. Uses include order sorting, shipping sorting, subassembly sorting to various assembly lines, and receiving sorting.

Circle 491 on Page 35

Numerical Control System

National Automatic Tool Co.—Richmond, Va.—6 page pamphlet—Data are contained in Bulletin 157-2 on a numerical control system. This system, designated Natcotrol, provides two or three axis control for single or multiple spindle machines. Standard 1-inch, eight-channel punched tape feeds information into the system. A 2-page bulletin supplement describes a single spindle, numerically controlled drilling, tapping, and milling machine.

Circle 492 on Page 35

General Purpose Relays

Hart Manufacturing Co., 110 Bartholomew Ave., Hartford 1, Conn.—8 page bulletin—Data are contained in Bulletin WU-09 on a line of Diamond H general purpose relays. The compact, 25-amp relays are shown in a variety of standard mounting arrangements with several optional types of terminals and eight different SP and DP contact combinations. Engineering data, specifications, dimension sketches, accessories, and typical applications are included.

Circle 493 on Page 35

Back Dryers

Tower Iron Works Inc., Providence, R. I.—4 page pamphlet—Data on a line of print goods back dryers are contained in Bulletin T-601. Standard 60-inch back drying cylinders are constructed using heavy gage stainless steel sheet with reversed flanged and dished heads, providing excellent rigidity without internal bracing. Cylinders are designed in accordance with the A.S.M.E. code for 50 psi working pressure. Complete stacks of cylinders are available in either horizontal or vertical arrangements. Brochure includes drawings of several ranges showing the dryer installation.

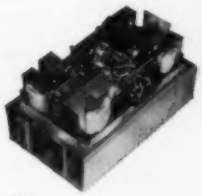
Circle 494 on Page 35

Pressure Indicator

Taber Instrument Corp., 107 Goundry St., North Tonawanda, N. Y.—2 page pamphlet—Redesigned Teledyne Model 236 pressure indicator is described and illustrated in Data Sheet P-60236. Designed for the remote indication of gas pressure,

NAME THE CHARACTERISTICS* YOU WANT IN STATIC POWER

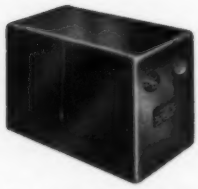
* Large Overload Capacity: 200%



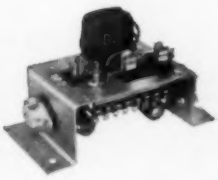
* Low Power Factor: 0.3 lagging to unity

* Dual Output: Single or Three Phase

* Wide Temperature Range: −55° C to +125° C

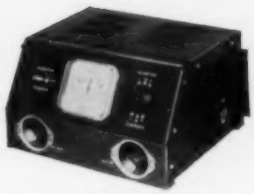


* Accurate Frequency Regulation: 400cps. ± 0.25%



* High Efficiency: 85% minimum

* High Voltage Output: 150 KV



* Dual-Purpose: Charger and Inverter

...for • industrial telemetry systems • remote or emergency signalling, warning or measuring systems • automated machine tools • microwave communication equipment

... wherever circuit interruption cannot be tolerated

You probably would not need all of the design/performance characteristics listed above in a single inverter. But today, after a three-year, full-scale development program, Hamilton Standard static inverters offer a wider range of proven design and operating characteristics than any you can buy—individually and in combinations. This means that Hamilton Standard static inverters can deliver the extra reliability, long maintenance-free service and quick starts heretofore unattainable with rotary power supplies.

If your equipment calls for a power supply with exceptional reliability, tell us about your complete requirements. We can provide the inverter you need.

What are inverters ... how, when and where to use them. A comprehensive aid for engineers. For your copy, write: Hamilton Standard Electronics, Broad Brook, Conn.

UNITED AIRCRAFT CORPORATION

HAMILTON STANDARD DIVISION

ELECTRONICS

Circle 725 on Page 35

fluid pressure, thrust, and torque, this device is shown in typical arrangement with a strain gage pressure transducer. Panel mounting information as well as adjustment and calibration procedures are included.

Circle 495 on Page 35

Mechanical Power Amplifier

Electronics Div., Seneca Falls Machine Co., Seneca Falls, N. Y.—2 page pamphlet—Bulletin EE 1009 details the operation and application of a mechanical power amplifier. Graphically illustrated with photographs, line drawings, and charts, the bulletin was developed as an aid for engineers in considering new applications for control systems. It discusses in detail the operation of this mechanical power amplifier, commonly used input sources, applications, and basic advantages of mechanical servo operation in contrast to other devices for amplifying power.

Circle 496 on Page 35

Chucking Automatics

Warner & Swasey Co., 5701 Carnegie Ave., Cleveland 3, Ohio—32 page handbook—Booklet 5803-3-58 presents application ideas for a line of single spindle chucking automatics. Featuring a large number of detail line drawings and photographs, the booklet describes machining jobs on 1AC, 2AC, and 3AC chucking automatics in various shops. Information on workpieces, tooling, machine functions, setup, and methods is provided.

Circle 497 on Page 35

Control Instrumentation

Aeronautical & Instrument Div., Robertshaw-Fulton Controls Co., Santa Ana Freeway at Euclid Ave., Anaheim, Calif.—8 page bulletin—Bulletin 10 covers Microsen closed-loop, all-electronic process control systems, capacitance actuated level detection and control instruments, and Vibraswitch malfunction detectors. Specifications for all process control instruments are provided. Bulletin covers functions and the manner in which both individual instruments and groups of instruments are used. Photographs accompany the various descriptions.

Circle 498 on Page 35

Magnetic Handling Units

Eriez Manufacturing Co., Erie 6, Pa.—50 page handbook—Booklet B-215 describes how a line of Hi-Powr permanent magnetic units can be the automation answer to many conveying, elevating, holding, and orienting problems. Schematic diagrams illustrate various applications as well as construction features of several magnetic units.

Circle 499 on Page 35

Generators

Howell Electric Motors Co., 16316 W. Seven Mile Rd., Detroit 35, Mich.—2 page pamphlet—Bulletin 700 A, B describes a line of ac and dc generators and motor generators. Generators range from ½ through 15 kva, ac, or ½ to 3 kw, dc. They are ideal for such applications as operational power for tools, saws, pumps, compressors for farms, timber tracts, camps or emergency power for schools and poultry farms; and special power needs for laboratories, processes, arc lights, refrigerated trucks or boxcar compressors. Motor generators produce direct current from ac power supply; single phase alternating current from dc.

Circle 500 on Page 35

High Vacuum Equipment

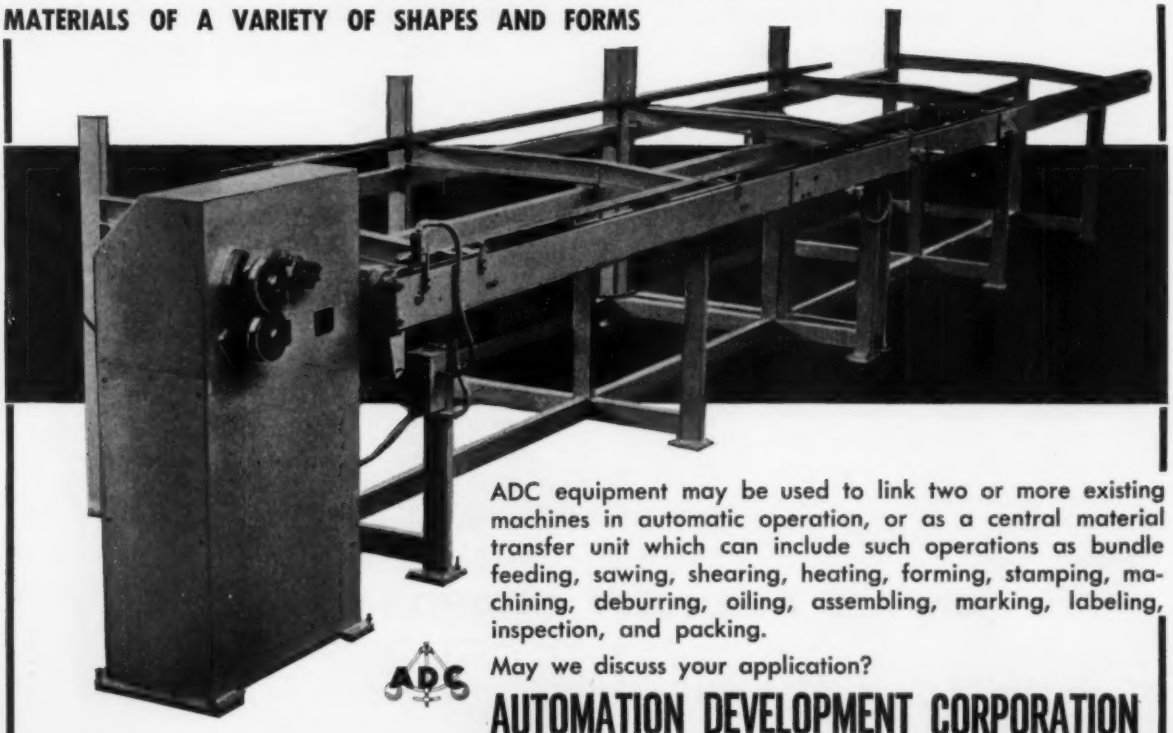
NRC Equipment Corp., Subsidiary, National Research Corp., 160 Charlemont St., Newton 61, Mass.—8 page bulletin—Catalog covers a line of high vacuum mechanical and diffusion pumps, valves, gages, accessories, portable pumping systems, coaters, furnaces, electron beam welders, altitude chambers, and freeze drying equipment. Photographs accompany the various descriptions.

Circle 501 on Page 35

Computer Format Recorder

Epsco Systems, Div., Epsco Inc., 275 Massachusetts Ave., Cambridge 39, Mass.—8 page bulletin—Model S-2010 solid-state recording unit which accepts digital data from a wide variety of sources and records it on magnetic tape in digital computer format is covered in this brochure. Details show how the recorder, when used in conjunction with a digital output data gathering system, automatically processes continuous data into gapped computer format magnetic tape thereby eliminating the need for hand coding

ADC SPECIALIZES IN HANDLING EQUIPMENT FOR BAR, BILLETS, ROD, PIPE AND OTHER MATERIALS OF A VARIETY OF SHAPES AND FORMS



ADC equipment may be used to link two or more existing machines in automatic operation, or as a central material transfer unit which can include such operations as bundle feeding, sawing, shearing, heating, forming, stamping, machining, deburring, oiling, assembling, marking, labeling, inspection, and packing.

May we discuss your application?

AUTOMATION DEVELOPMENT CORPORATION

135 Reynolds Rd., Mentor, Ohio, WH 2-8300

of analog test data for computer processing. Input data rates are limited only by the tape writing speed of the particular computer format, and may be as high as 30,000 characters per second.

Circle 502 on Page 35

Winding Machines

Geo. Stevens Mfg. Co. Inc., Pulaski Rd. at Peterson, Chicago 46, Ill.—12 page booklet—Data are contained in this catalog on a line of heavy-duty transformer and field coil winding machines. Technical details are provided on 14 machines which include: Multiple distribution transformer winders capable of winding wire as heavy as 2 AWG in multiples; multiple transformer winders capable of winding wire 7-31 and 10-31 AWG; and various hand winders. Three heavy-duty tensioners, Models T-150, 92-12, and 92-6D, are also described.

Circle 503 on Page 35

Electrical Heating Equipment

Edwin L. Wiegand Co., Advertising Dept., 7500 Thomas Blvd., Pittsburgh 8, Pa.—24 page catalog—Catalog supplement CS-600 contains specifications for Chromalox electric heater bands, air heating elements, blower-type heaters, immersion units, engine heaters, mineral insulated heating cable, special radiant heaters for process and comfort heating, controls, and various other elements and equipment. Photographs and schematic diagrams illustrate the various items.

Circle 504 on Page 35

Adjustable Speed Drives

General Electric Co., Schenectady 5, N. Y.—16 page booklet—Booklet GEA-6806 describes a ¼-25 hp line of Polydyne mechanical adjustable speed drives. It includes details on principles of operation, configurations and features, mounting positions, rating tables, and a description of available accessories. Several models are illustrated.

Circle 505 on Page 35

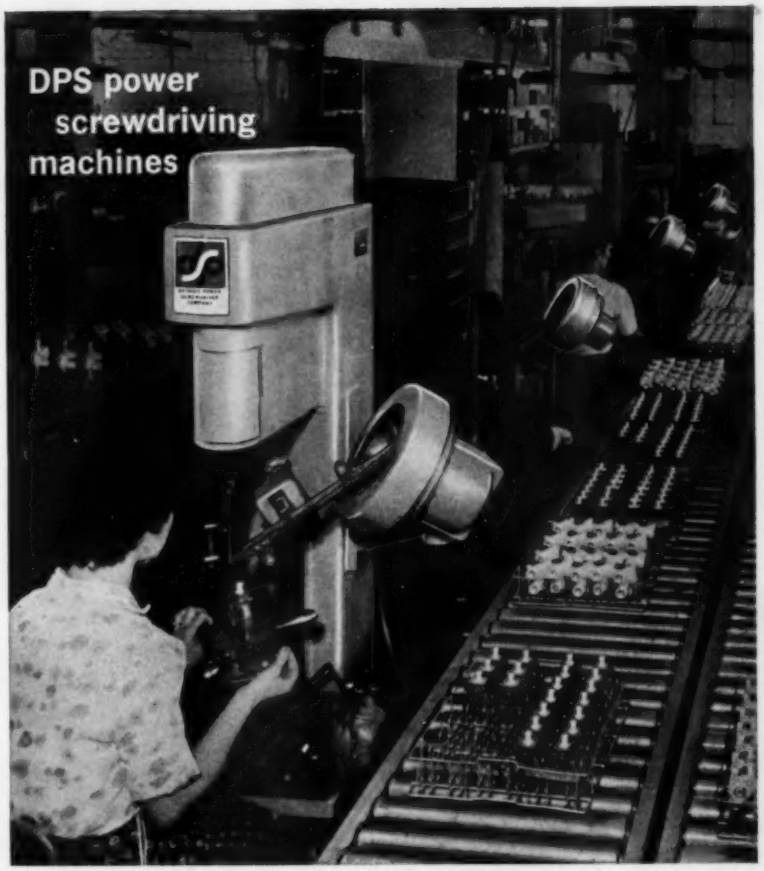
Indexing Machine Chassis

Swanson-Erie Corp., 814 E. 8th St., Erie, Pa.—8 page bulletin—Bulletin describes the operating features of an Auto-Tran straight-line indexing machine chassis. Specifically designed to accommodate a variety of sequential automatic processing and assembly operations, this device features a self-contained drive unit for continuous or intermittent work transfer and a rigid base for mounting operational tooling. The chassis can be used as a basis for completely automatic machines or for combinations of manual and semi-automatic operations. It is available in a number of standard lengths and index strokes.

Circle 506 on Page 35

Rotary Kiln Controls

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—8 page brochure—Bulletin 600 contains data regarding a line of metering and control instruments for rotary kilns and associated equipment. It discusses the advantages of an approach for instrumentation in which kiln, cooler, mills, and feeders are considered as one



drive screws and nuts fast . . .
mar-free and accurately

Something as small as an inaccurately driven screw or nut can cause parts to be rejected. And that costs you money both in parts waste and time lost.

DPS Model U power screwdriving machines drive screws and nuts with the accuracy that improves assembly quality, reduces rejects. They give you speed, too. Drive up to 40 screws or nuts per minute.

The Model U is available in two types . . . pedestal and self-contained driving head. Both require only a minimum of space and are easily adaptable to your work flow. Feeder mounts on either side of machine column for right- or left-hand assembly. Other features include a positive control clutch which maintains constant driving torque, motorized hopper drive with safety clutch, and fully adjustable feed track and escapement mechanism.

DPS Model U drives screws from #6 x 3/16" long to ¼" x 1½" long and can be equipped with 12" or 16" rotary feeders. Write for Model U bulletin.

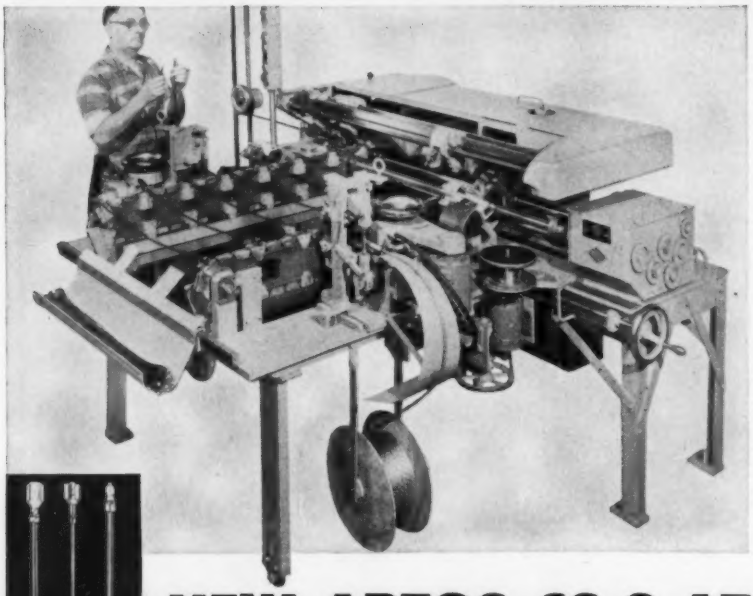
DETROIT POWER SCREWDRIVER CO.
A Subsidiary of Link-Belt Company

Selective Parts Feeders; Screw, Nut and Stud Driving Machines; Special Purpose Assembly Machines

2811 W. Fort Street
Detroit 16, Michigan
TAshmoo 5-3070

Circle 726 on Page 35

Produce 4,000 finished wire leads per hour...with terminals at both ends!



NEW ARTOS CS-9-AT AUTOMATIC MACHINE

1. measures any type of wire.
2. cuts off wire to length.
3. strips one or both ends.
4. attaches terminals at both ends.
5. provides stations for other work.

NOW YOU CAN produce up to 4,000 finished wire leads per hour—*with terminals attached at both ends*—when you install this new high-speed machine.

The ARTOS CS-9-AT handles almost any type of wire automatically. Taking wire from the reel, it measures, cuts to length, strips insulation, attaches terminals and provides uniform collection of the finished leads. Most types of terminals in prefabricated strip form can be used.

Also, the machine is furnished with a multi-station conveyor that permits several stations to be used for secondary operations such as inspection, twisting, welding, etc.

Get the complete story on the new ARTOS CS-9-AT—ask for engineering advice on your special problems.

ARTOS CS-9-AT CAPACITY

Wire Sizes: 20-gauge to 4-gauge.
Cutting Lengths: 6" min. to 90" max.
Stripping Lengths: 3/16" to 1½".
Output: 6"-45" lengths—4,000 per hr.
45"-90" lengths—2,000 per hr.

Write for Free Bulletins

Bulletin 358 describes CS-9-AT machine. Also ask about other Artos machines to handle wire from 30 to 000 gauge; cut lengths from 2 in. to 45 ft.; strip insulation from 3/16 in. to 10½ in.

AGENTS THROUGHOUT THE WORLD

World Leaders in Automatic Machines for Finishing Wire Leads

ARTOS ENGINEERING CO.

2785 South 28th Street • Milwaukee 46, Wisconsin

interrelated system. Illustrations of applications and components are included along with descriptions and diagrams of modern kilns, mills, and coolers. Record charts compare kiln performance for guided versus unguided operation.

Circle 507 on Page 35

Component Handling Devices

Design Tool Co., Div., Federal Manufacturing & Engineering Corp., 1055 Stewart Ave., Garden City, L. I., N. Y.—12 page booklet—Catalog features a line of automatic component handling devices designed for use by electronic component manufacturers and volume users of capacitors, transistors, coils, and other components. It contains full data on axial lead straightening machines, lead trimming and bending machines, circuit board inserting and assembly machines, as well as a variety of automatic devices designed to operate at high speeds with card loaded or bulk loaded components.

Circle 508 on Page 35

Data Recording Instruments

Photomechanisms Inc., Huntington Station, L. I., N. Y.—20 page booklet—Instruments that combine the sensing powers of electronics, optics, and photography for rapid capture and display of scientific and industrial data are described in this brochure. Descriptions and explanations of ten instruments are provided. These instruments include rapid film processing cameras, oscilloscope trace recording units, a line of cameras for x-ray cineflurography, and a device for automatic measurement of the bacteria content of the atmosphere.

Circle 509 on Page 35

Electronic Monitoring System

Lynch Communication Systems Inc., 695 Bryant St., San Francisco, Calif.—8 page bulletin — Data are contained in Form-B1020-SB-1 on a high-speed continuous electronic monitoring system which can accurately monitor any condition that can be represented by an electrical contact closure. Continuous scanning of the system makes interrogation unnecessary so that only one direction of transmission is required. The system utilizes error-checking circuits which permit only valid information to be displayed. Typical applications include circuit breakers, motor driven valves, hazardous atmosphere sensing devices, pressure switches, level switches, and for transmission of binary coded analog data.

Circle 510 on Page 35

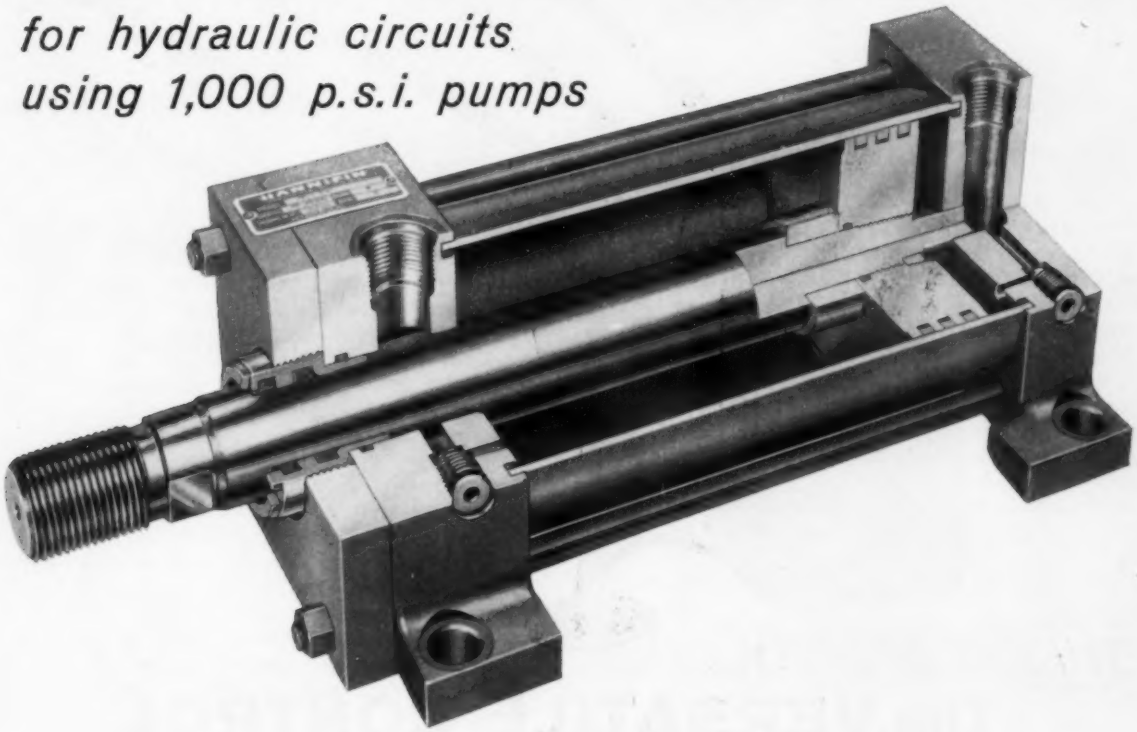
Magnetic Triggers

Ovitron Corp., 37-05 48th Ave., Long Island City 1, N. Y.—12 page booklet—Specification sheets contain data regarding a line of magnetic triggers designed to control accurately the firing of silicon controlled rectifiers in response to dc or ac signals. The triggers are available for applications where silicon controlled rectifiers can be used as proportional power control elements, power amplifiers, or solid state switches and relays. Features include small size, light weight, high outputs limited to prevent exceeding gate ratings, full range firing, fast response, high sensitivity, and full isolation.

Circle 511 on Page 35

NEW FROM HANNIFIN
THE THOUSAND POUND LINE!

for hydraulic circuits using 1,000 p.s.i. pumps



- *A true hydraulic cylinder – not a modified air cylinder*
- *Offered in nine bore sizes – 1" through 8"*
- *Every model withstands at least 1,000 p.s.i. in every bore size*
- *Built to save you money – yet not "built to a price"*

Now, for the first time in hydraulic cylinder manufacture, Hannifin offers a top quality cylinder tailored to the medium-high-pressure hydraulic circuits you operate off 1,000 p.s.i. pumps.

Series "L," the "Thousand Pound Line," is NOT a modified heavy duty air cylinder. It is built for the job . . . with steel heads and steel barrel for full compliance with J.I.C. hydraulic recommendations. Other extra-quality features include an induction hardened and hard chrome plated rod, nodular iron piston with cast-iron piston rings — leakproof "Lipseals®," optional — longer cushions on cushioned models, and the Hannifin-developed bronze cartridge gland with both "Lipseal®" and "Wiperseal" to keep the rod drip-free. S.A.E. straight thread "O" ring ports as recommended by J.I.C. are optional at no extra cost just as they are in the Hannifin heavy duty Series "H" hydraulic cylinder.

Parker-Hannifin field engineering service can help you meet your needs precisely, help you select the proper Hannifin cylinder for any service, air or hydraulic. Call your nearest Parker-Hannifin sales office or write direct for our new bulletin giving all dimensions of Hannifin Series "L" cylinders.

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Circle 728 on Page 35

33% fewer components!

Traverse speeds up to 1000" per minute!

Accuracy unaffected by age, wear or temperature!

No shift registers or memory storage!

Manual and tape input!

Easy to program!

Easy to maintain!

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The **VERSATILE CONTROL**

For your numerical control application, here at last is a truly versatile control, with *adjustable* speed and accuracy to fit almost any operational need.

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The initial accuracy of a Sperry Control continues throughout its life. Precise linear transducers used are unaffected by temperature, age or wear. These transducers are mounted parallel to machine motion, and do not rely on lead-screws, racks, pinions, or other mechanical devices.

THE DRIVE SYSTEM:

Sperry Controls employ an exclusive electro-hydraulic servo valve of simple design, without linkages, springs or 'dither impulse'. The valve accurately controls hydraulic motors or cylinders. Most machines with Sperry systems offer high speed cylinder drives which eliminate expensive and hard to maintain ball screws.

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The Sperry Control uses EIA standard 1" 8-track paper or mylar tape and EIA standard coding. The pneumatic block reader provides one two co-ordinate position and auxiliary commands in only .1 second. Air pressure keeps the tape clean and eliminates reading errors due to brush or contact contamination. For short or simple programs, manual input switches are provided as standard equipment.

More systems application data for your particular machine or process may be obtained from:

SPERRY

SPERRY GYROSCOPE COMPANY OF CANADA, LTD.

P.O. Box 710, Montreal 3, Que.

Circle 729 on Page 35

AUTOMATION abstracts

CONTROL VERSATILITY

By NORMAN L. CABAN
Industrial Engineering Dept.
Westinghouse Electric Corp.
East Pittsburgh, Pa.

AS AUTOMATED MACHINES continue to grow in complexity, the need for versatile control equipment becomes evident. Accomplishments to meet these requirements are exemplified by Westinghouse's Prodac control apparatus that has been applied in the steel making process, varying in complexity from a simple positioning system on the mill screwdown to a complete digital computer for programming an entire mill. This same equipment has been used to produce an optimizing computer employed in the chemical and processing industries. Also being applied are numerical control systems for machine tools that use the Prodac apparatus. And the basic machine tool system has been used for controlling a glass scribing machine and such systems as a press feed line.

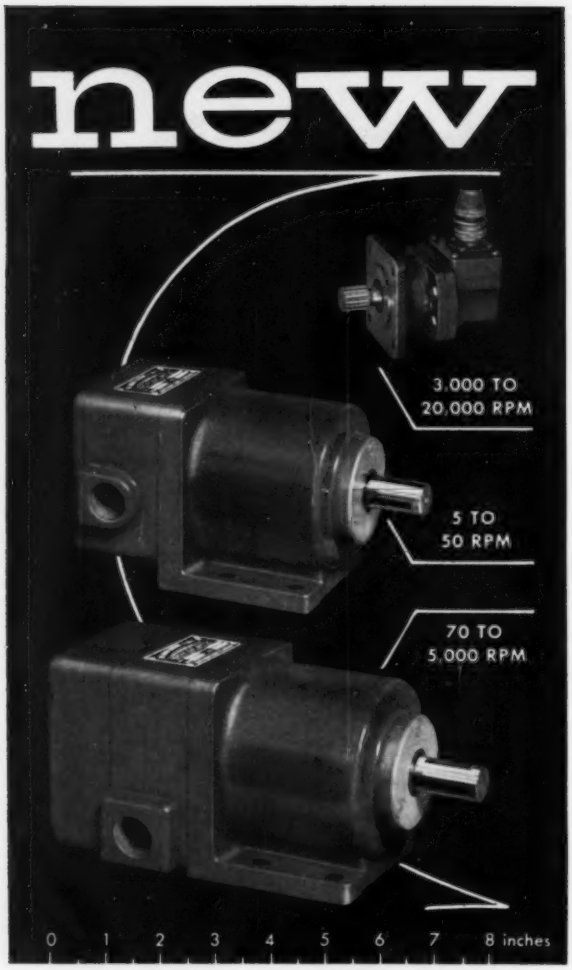
The Prodac control apparatus uses the transistor NOR circuit as a basic building block which enables controls to be built to perform such logic as counting, adding, subtracting, dividing, comparing, and multiplexing. The equipment is constructed for application in atmospheres which can vary from an air conditioned office to a hot mill or machine shop. The versatility, reliability and ruggedness of the control apparatus makes it an ideal tool for the numerical control of machine tools. Numerical control equipment must perform the functions of decoding, computation, positioning, and logic. The logic required of the numerical control equipment includes initiating of auxiliary functions and selecting certain fixed sequences such as turret cycles on a drilling machine. Logic requirements vary with every manufacturer and every machine tool. The functions of decoding and computation are growing in importance. Programming problems are of major concern to the users of numerically controlled machine tools. Therefore, it is desirable to allow the control equipment to make many of the computations required in the programming process and permit programming by less skilled operators. In order to assist a programmer, the control can be built to accept either absolute or incremental programming. It can be built with floating zero or full range offset. Correction of data may be accomplished from measuring devices or predictable changes. Other features, such as plus or minus programming and mirror image control, are possible.

Machine Tool Applications

Prodac numerical control systems have been applied to many types of machine tools including Gisholt turret lathe, Moore jig borer, Brown & Sharpe turret drill, Burgmaster turret drill, and Avey Drilling turret drill.

The control apparatus also has been combined with a hydraulic drive system to position the table and a 150-ton Wiedemann turret punch press. This table is

Tape controls for horizontal drilling and tapping machine, left, position column and head and index one of the two work tables in front of the machine. Upper photograph shows 150-ton turret punch press. Table of punch press can be positioned at rate of 500 ipm. High speed tape reader plus high positioning speed enables 25 hits per minute to be made.



SPEED-RESPONSIVE SWITCHES

These control-circuit switches, depending on the type, are responsive to changes in speed from 1¼ to 20,000 rpm and direction of rotation. Contact adjustment may be made while running. Rugged construction, several contact arrangements and consistent accuracy make them suitable for applications such as zero-speed or plugging switches on machine tools, as over-speed or under-speed switches on rotating machines and drives of all types, as anti-plugging switches on machinery with inertia loads and as interlocking switches for conveyor systems. Ask for descriptive Bulletins 2210, 2220 and 2230.

Designs for special applications have been manufactured. Let us know your specifications.

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positioned at a rate of 500 inches per minute to an electrical accuracy band of two thousandths of an inch. In addition, the 32-position turret is positioned. In this system, the conventional digital-to-analogue converter and Trinistor amplifier were replaced by a static transistorized computing amplifier and hydraulic servo valves. The use of a high-speed tape reader combined with high-positioning speed permitted a fantastic cycling of 25 hits per minute. A similar system will be applied to smaller Wiedemann punch presses.

The first integral horsepower drives were applied to a Swift Ohio drilling machine. This horizontal drilling and tapping machine has two tables—one stationary and the other numerically indexed to one of four positions. Tape controls position the column over 105 inches and head over 50 inches. Tape selected head sequences permit drilling, tapping, countersinking and tool changing. Spindle feed and speeds are also tape controlled. Because this machine has a tool magazine which is stationary, floating zero was impractical. Therefore, an automatic calibration system was included. When a zero-set button is depressed, the machine will rapid traverse toward zero in both coordinates. Near zero slowdown is signaled by a limit switch. At zero, a proximity limit switch is tripped. The tripping of the proximity switch, combined with a signal from the Rotrac pulse generator, establishes zero to an accuracy of 0.00025 inch.

A special tape-handling system produces a continuous tape to control the machine from short master tapes. The machine is used for drilling and tapping d-c motor frames. Master tapes are produced for each frame size of motor.

Special Purpose Machines

Several Prodac control systems have been built for special purpose machines. Two different machines produced by the Gear-O-Mation Div. of Michigan Tool Co., are being built for the new Westinghouse transformer plant in Muncie, Ind. One machine is a special milling machine which will mill a beveled edge on a special paper washer used in large transformers. This is a large gantry-type machine with a milling cutter that can be indexed in 90-degree increments. The control apparatus positions the bridge to make straight cuts along the one edge of the washer, signal for a 90-degree rotation of the cutter at a corner, and then position the saddle across the bridge for cuts along the end. The radius of cut is adjusted manually.

The second machine will place spacers on the transformer washer to permit the flow of oil over the transformer coils. These spacers must be placed at programmed points to permit proper flow. This machine consists of four heads that work on different portions of the washer simultaneously. Each head positions, sprays glue on the washer, and then places the spacer.

A third machine for the new Westinghouse plant in Muncie, Ind., is being built by the Burke Porter Machine Co. This is a special drilling and sawing gantry-type machine with a saddle holding both a drill head and a saw. The machine is used for drilling and sawing Micarta sections up to three inches thick. The

Circle 730 on Page 35

control apparatus is used to position the bridge and the saddle. The drill and saw cycles are also tape programmed.

A special Prodac control system has been supplied to the Mesta Machine Co. for the automatic control of a roll grinder. This system does not use a tape reader. A set of dials are provided so that an operator can set up the final and initial diameters of a particular roll to be ground. The control apparatus will compute the number of passes to be made and the amount of infeed for each pass and automatically position the grinding wheel for each pass across the roll. A set of dials within the control cabinet permits presetting the number of passes and amount of infeed for each pass or group of passes dependent on the amount of metal to be removed.

For example, it can be preset so that the last 3 passes involve no infeed at all, the preceding 6 passes infeed 0.0005 inch, the 10 passes proceeding infeed 0.001 inch, and so on. These presettings are made by the foreman, and the switches are locked in the control cabinet. The control determines the total metal to be removed from the initial and final diameter settings and then promptly rejects all preset passes that would have the machine grinding in air. The control then directs the machine to perform the remaining cycles to finish the roll.

From a paper entitled "Prodac and Versatility" presented at the 25th Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corp., Pittsburgh, April, 1960.

DISTRIBUTION MATERIALS HANDLING

By RICHARD L. SPEAKER
President
Speaker Sortation Systems Inc.
Butler, Wis.

WHILE the greatest strides in material handling have been made in the manufacturing area of industry, there is every reason to believe that the cost reductions in sorting, packaging, and moving goods to the consumer can equal or exceed the cost reductions experienced by automating production facilities. In fact, it is somewhat of a paradox that in an area where the potential is so great the technology seems comparatively underdeveloped. Statistics show distribution productivity is gaining on the average of 1 per cent annually, as against 3 per cent for the general economy.

Interestingly and logically enough, the closer you get to the distribution sector of our economy, the higher the proportion of labor costs that are involved in materials-handling. In some cases, according to one authority, it often approaches 100 per cent.

The increase in automation of warehousing will have a tremendous impact on the materials-handling industry. Warehouse handling equipment will grow from less than 1 per cent of the industry's annual sales to more than 10 per cent by 1970. Cost of automatic warehousing equipment installations will rise from less than three million dollars this year to more than $300 million in 1970. Similar impact will be felt in electrical and electronic controls, data processing equip-

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Circle 731 on Page 35

ment, and building construction.

Too many of the materials handling systems that have been tried in distribution have employed modified production line techniques instead of being carefully tailored to meet the specific needs of a distribution system. Perhaps this is because we have tended to regard distribution as some sort of sideline of manufacturing, when in fact it requires its own technology. Here then is the next big growth area for materials handling. Perhaps our biggest single frontier for cost savings.

Types of Distribution

Distribution is divided into three basic types. We have warehouses, places where there is usually a single source of incoming products such as one factory, but there are many destinations for these products.

Next, we have transfer terminals, such as Post Offices, railway and airline terminals, parcel delivery services and freight houses where merchandise merely is received from a multiplicity of sources and assembled for transfer to other destinations and then redirected to those destinations.

Thirdly, we have distribution centers, such as those maintained by mail order houses or by centralized parts warehouses, serving an entire industry or a geographical area. In the case of the distribution center we have multiple sources from which products come and multiple destinations, with intermediate operations of sorting, picking, and packing orders.

Receiving, storing, picking (or order assembly), packing, and shipping are the unit operations performed in each of the categories. Today, reliable, soundly engineered equipment is available to automate such unit operations as picking, order assembly, sorting, and sometimes storing, packing and shipping. These can often be combined with existing manual methods in such a way that complete conversion to automatic methods can be made as the right kind of equipment becomes available. Automatic warehousing is the next great frontier of materials handling, but to do a complete job requires advanced sophistication in several areas, including data processing as well as equipment design and control. As we master the technology, we will make a growing contribution to distribution economics.

Of these various unit operations of distribution, sorting of packages is perhaps the furthest advanced of them all, for it lends itself readily to automation. There are basically three different types of sorters which have proven records of accomplishment: These are the ordinary belt, live roller, or slat conveyors with diverters or pushoffs stationed at each sorting point; the slat conveyor with movable diverter blades built into each slat; and the tipping tray. The successful operation of any of these types depends considerably upon proper control and programming of the sorting information, and especially proper application of the equipment to the problem.

We visualize three general concepts of control. In one, visual supervision, diverting devices are remotely

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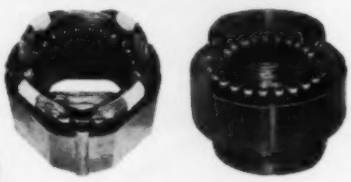

*LOWEST MACHINE INVESTMENT PER UNIT PRODUCED.

- Winding speed at 325 RPM
- Preparation time: 4-pole, ¼ minute; 2-pole, ¾ minute.
- One operator can readily tend two or more machines.
- Automatic cutting and anchoring of leads.
- Winds greater range of stator lengths.

* Production example: 4-pole stator with 3-group concentric coil per pole at 125 turns per coil produces 88 stators per hour; 2-pole with 5-group concentric coil per pole at 159 turns produces 58 stators per hour.

actuated when a commodity is seen to be in the desired diverting position—or when it is located so that its time relationship with the diverting point can be established and a time delay circuit employed. In the second concept, programmed or keyed information accompanies each parcel through the sorting area and causes operation of the proper diverting medium at the right instant. The third concept involves analog memory devices directed by keyboard or fully electronic inputs, which match the actual path of the commodity with a simulated path through an electronic or mechanical circuit and actuate the diverters remotely upon a signal from the memory circuit.

Practical Aspects

Each type of sorter and each type of control is especially adaptable to certain parameters of sorting. Sorting from power conveyors with remote controlled diverters or power sweepoff has proved practical where commodity size varies only through a small range, where capacity requirements are below 600 to 1000 cases per hour, and where the number of sorts is low. At higher speeds the pushoffs become "swat offs" and commodity damage must be considered.

The flat conveyor with movable integral diverters is an interesting development and it permits packages of miscellaneous length to be spaced closely on the conveyor with the number of diverting blades energized at any one sorting position determined by the length of the particular commodity being diverted. This has proven practical where the commodities are irregular and widely varying in size, and where a large volume of commodities need be sorted into only a few categories so that the overall size of the unit can be kept down to a minimum. Its big advantage is its capacity to handle an almost unlimited variety of sizes and shapes at rates much higher than conveyors with stationary sweepoffs. Its disadvantage is high cost per foot.

In the wide range of applications where through-put is high and number of sorts is great, tipping tray sorters with capacities up to 6000 or more commodities per hour per input and with unlimited number of sorts permissible at relatively low cost per sort, appear to show the best performance and economies. Thus far, in addition to dozens of Post Office applications, now in the process of design or construction, the tipping tray principle has been applied to the mail order field and more recently in the automotive parts warehouse field.

As a rule of thumb, an operation can be automated with specialized sortation equipment if more than 10 sorts must be performed, if through-put is above 20 cases per minute, and if adequate data processing of paper work is available. Below these levels, mechanical systems of conveyors and diverters, controlled manually by one operator, may be more practical and less expensive than specialized sorters. If your sorting is tied to order assembly, we use a rule of thumb of about 500 or more orders per shift as a minimum through-put to justify automatic equipment.

Basically, we need the answers to five questions in order to analyze the application of automatic sortation: First, how many sorts must be made? Second,

PROXIMITY LIMIT SWITCHES

ALL STATIC—ACCURATELY LIMIT THE MOVEMENT OF MACHINES OR PARTS

Reliable—rugged—all static—corrosion resistant—can't wear out.

Not affected by oil mist, iron filings, sand, dust, dirt or water. Very successful in underwater applications. Tripped by any magnetic material. Has passed Navy shock and vibration tests (MIL-S-901B) and (MIL-STD 167).

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2. Control element — picks up the signal from the head and drives static control components, relays or solenoids;
3. 115 v, 60 c, supply line and head-to-element lead. Normally each sensing head requires its own control element, although in special applications up to six heads can be used on a single element.

OPERATING PARAMETERS:

Two operating distances: Adjustable ⅛"—½"; ¼"—2". 5-20 operations per second. Response time, 25 milliseconds. Sensitivity to turn off: 20% at maximum trip distance; 5% at minimum trip distance. Control element output: 8 w, 24 v d-c at 335 ma, 60 cps.

For specific or test applications, send your order or request for further technical information direct to General Purpose Control Dept., P.O. Box 2025, Buffalo 5, N.Y.

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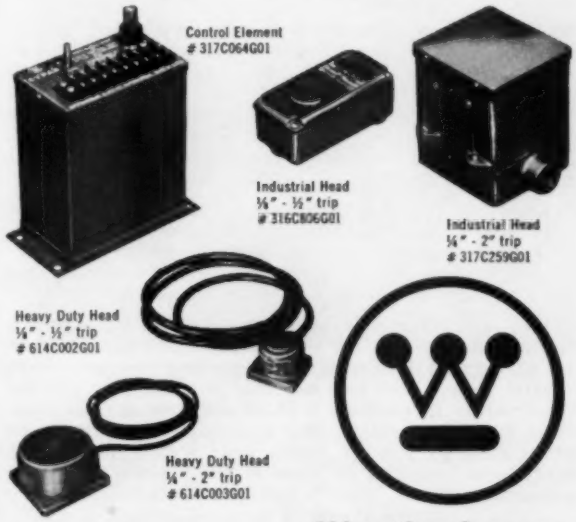

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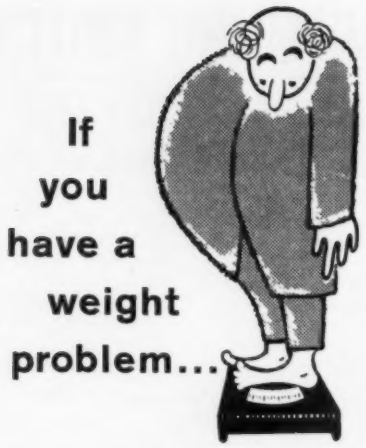
Circle 733 on Page 35



Our business is solving other people's weight problems. Usually, these problems involve wanting to know exactly how much weight passes over a conveyor in a given time period. Often, the problem is to control the flow of material into a continuous mixing process. And frequently, somebody asks us to help him automate a complete process system, with interlocks, time delay relays, and complete circuitry control systems.

All the problems we solve have two things in common: measurement or control of the amount of material *by weight*, which is a far more accurate way of doing it than by volume; and secondly, the fact that the material is *in transit* during the weighing and controlling.

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In our existing line of Weightometers® and Feedoweights,® we now have so many different types of standard equipment . . . at last count, it was approaching 200 . . . that there is virtually no existing set of requirements that at least one of them can't answer. We can give you electrical, electronic, hydraulic or mechanical systems. And in the very rare cases where one of our standard models can't be used, we'll engineer one for you.

Moreover, if you already have a conveyor weighing or feeding system in operation, we can automate it for you, no matter whether your arrangement is mechanical, electro-mechanical, hydraulic or electronic. We can do this for you with the new Merrick Rate Transducer.

This is an ingenious device, if we do say so, that can be fitted to any Merrick Weightometer, no matter what its vintage. It produces a straight-line voltage output control signal. You can use this to control or provide information in a whole host of different applications. With it, you can relate other process steps to your conveyor feed. Or you can couple your Weightometer to a continuous recorder, or make it feed information into a computer.

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So after fifty-three years in the business, the Merrick line is still the most modern, most adaptable that you can find anywhere. Why not drop us a card? We'll be glad to send you our latest literature.

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how many items are to be processed per hour? Third, what are the size, weight, and physical characteristics of the packages to be sorted? Fourth, is coordinating data processing equipment available? Fifth, what are the physical limitations of the sorting area itself—its shape, height, live load capacity, aisle dimensions, and systems available for feeding and discharging packages?

Armed with this information, an experienced sortation engineer knowing the problems and pitfalls of improper judgment, can reliably analyze each situation and recommend for or against automatic sortation.

From a paper entitled "Automating the Consolidation and Sorting of Packages" presented at the Technical Conference of American Material Handling Society, Philadelphia, May, 1961.

NATIONAL IMPLICATIONS OF AUTOMATION

By JOHN DIEBOLD
President
John Diebold & Associates Inc.
New York, N. Y.

AUTOMATION is the future—the role of government must be to lead us as rapidly as possible into this era and at the same time insure as smooth a transition as possible. Let us first clarify why we must wholeheartedly support the rapid introduction of this new technology.

It is an economic necessity. What automation means is increased productivity—the key to economic growth. The much criticized sluggishness of our economy is symptomatic of our failure to apply new technology fast enough. The extent of our ability to raise productivity essentially determines our rate of economic growth.

Automation is a political necessity. Our political institutions will neither survive nor spread because of ideological supremacy alone—we must also continue to have the most advanced technology the world has seen. Russia, for example, knows that automation represents a grand opportunity to stimulate the rate of industrial growth. No arbitrary limits have been placed upon the development or use of automatic machines and systems in the USSR.

We have no choice between the status quo and the automation age. Change is a certainty. We have a choice between being led, reluctantly, into this new world—or leading in the introduction of new technology both at home and abroad.

Our position in international trade depends on technological supremacy. We pioneered in the technology of mass production and this had much to do with the fact that we are now the richest nation in the world. The automobile assembly line, for example, created not only a tremendous export trade, but high wages and an unsurpassed standard of living. Today we can maintain this advantage only by pioneering in automation technology. Average hourly wages paid to American workers in manufacturing industries in 1959 was $2.68. How does this compare with rates paid in

Circle 734 on Page 35

foreign countries? The French National Institute of Statistics and Economic Studies recently released these figures showing comparable wage rates in other countries: Sweden $1.08; West Germany $0.78; Switzerland $0.77; Britain $0.77; France $0.72; and Italy $0.61.

My own experience overseas indicates that other nations are committed to aggressive development and use of automation. Our automobile plants are no longer ahead of European production methods—and with the emerging community of nations, our distribution advantage is losing ground. We must continue to excel in technological innovation. This means automation.

The absolute necessity to automate—and to automate as quickly and effectively as possible—is certainly a compelling one, and the most constructive policies are those that encourage automation. But we must also consider the problems that such a policy will raise.

The greatest impact of automation will not be felt only in the factory and it is essental to keep in mind the comprehensiveness of change our society must face.

For instance it is the estimate of my firm that more than 20,000 computers will be installed by 1970; and that long line communications among office machines over telephone circuits will exceed long line voice communications by 1970. It is also my opinion that this industrial use will be exceeded by other uses—libraries, medical research, government administration, space technology.

The education challenge is the greatest we must face. We will not only have to tremendously increase our education facilities, but will have to change many of our accepted concepts, for example: 1. Education, training, and retraining must be viewed as a continual lifelong process—not as a stage of youth. 2. We must immediately graduate scientists, engineers, and technicians in vastly increased quantities—without sacrificing quality. 3. We must completely revamp our business education so that our managers may use new technology effectively. 4. We must prepare our youth to live in a world where the only certainty is change, and where leisure becomes the core, rather than the fringe of life.

From testimony presented before the Sub-Committee on Unemployment—Automation of the U. S. House of Representatives Committee on Education and Labor, Washington, D. C., March, 1961.

COMPUTERS AND LIQUID PIPELINES

By G. H. BECK
Senior Engineer
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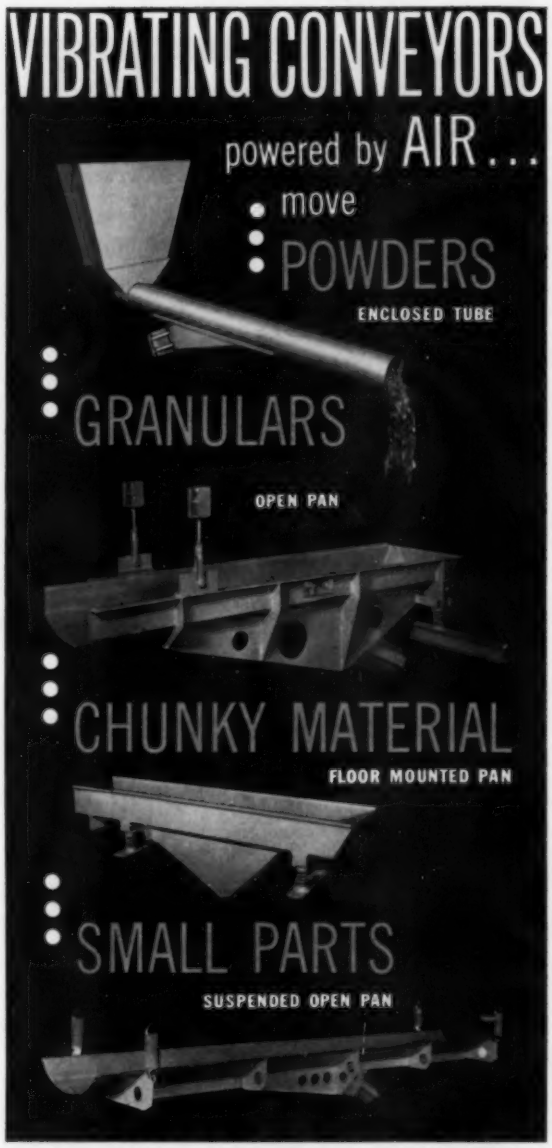
Tulsa, Okla.

MANY highly automatic data logging systems are installed on large pipeline systems and a great volume of data is taken. The evaluation of these voluminous records by trained personnel to determine techniques for increased efficiency is impractical due to the cost. The evaluation of these logs is an ideal task for an off-line general purpose computer. There are several additional functions an off-line computer might perform. Among these are: 1. Scheduling, including



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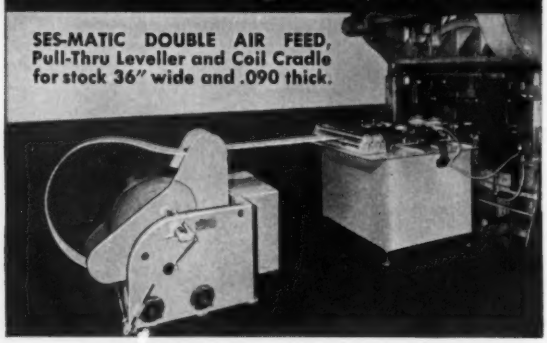

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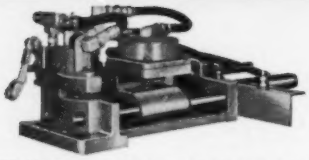

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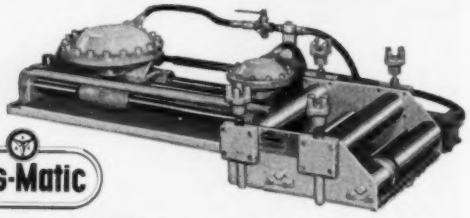

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the sequencing of products to provide minimum contamination; checking for adequate storage at receiving points; co-ordination of schedules to meet batch size minimums at end points; etc. 2. Computing optimum flow rates to meet a schedule. 3. Keeping track of batch changes and their expected arrivals at various points on a system. 4. Preparing forecasts of operating costs, income, and pipeline capacity required. 5. Preparing stock or inventory reports. 6. General accounting and payroll functions. 7. Market studies for economic analysis of extensions of the pipeline or additional marketing outlets along existing pipeline systems.

In recent years more attention has been given to the use of computer techniques at the local level to reduce power costs at individual stations. The local computer approach is certainly one practical solution when large multiunit electric stations are part of an existing pipeline system. The application of similar principles to engine driven stations or to variable speed electric drive systems is not appreciably different. It must be pointed out, however, that the most economical operation at each individual station might not be the most economical for the system as a whole.

Other problems that might lend themselves to local computer control include: 1. Special hydraulic problems peculiar to a particular station. 2. Problems related to high viscosity crudes and the effect of temperature on their ability to be pumped. 3. Changes in operating units available due to local malfunction. 4. Power rates that allow special discounts for power used during power company off-peak periods.

A concept recently introduced in the natural gas pipeline business is that of using a combination computer control system. At each individual station a local control computer would control the individual station. An off-line computer at the dispatch center would receive information from the stations and from market and supply sources. It would make the necessary calculations and present the schedule to the dispatcher. Obviously, the information could be fed directly from the master computer to the individual station computers without being checked by the dispatcher, if confidence in the system were high enough.

This approach is the most likely to be accepted by the liquid pipeline industry. It has several advantages:

1. Communication circuit failure is no longer an intolerable problem since the individual stations would have a memory and would not require constant supervision.
2. Computer equipment installed at the remote stations need not be identical.
3. Because less data is required to be transmitted, either less circuits or less expensive circuits can be used.
4. The prime computer is available for other functions on a part time basis.
5. The dispatcher can override the prime computer as required without losing the savings available with computer control since each station will still attempt to operate as its preset condition.
6. The system can be installed in increments.
7. A prime computer could be shared by more than one pipeline owned by the same company.

From a paper entitled "What Comes After Data Logging" presented at the Winter Instrumentation-Automation Conference of the Instrument Society of America, St. Louis, January 1961.

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PHYSICAL DISTRIBUTION MANAGEMENT

By E. W. Smykay and F. H. Mossman, Dept. of Marketing and Transportation Administration, Michigan State University, and D. J. Bowersox, assistant director, Business Development, Railway Express Agency; 283 pages, 6 by 9¼ inches, published by Macmillan Co., New York; available from AUTOMATION; *$8.00 postpaid.*

Although a phase of marketing, physical distribution and its related problems are often overshadowed by emphasis on such topics as marketing research. The authors point out that significant economies can be achieved if an integrated approach is taken in examining the distribution function, particularly in the light of advances in computers and operations research.

ADAPTIVE CONTROL SYSTEMS

Edited by Eli Mishkin, professor of electrical engineering, and Ludwig Braun, Jr., assistant professor of electrical engineering, Polytechnical Institute of Brooklyn; 533 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$16.50 postpaid.*

The eleven contributors to this book are all of the Electrical Engineering Dept. and Microwave Research Institute, Polytechnic Institute of Brooklyn. Divided into four parts, the book deals with linear systems in part one; nonlinear systems in part two; adaptive systems in part three; and selected topics in systems engineering in part four.

CREATIVE ENGINEERING DESIGN

By Harold R. Buhl, Dept. of Mechanical Engineering, Iowa State University; 195 pages, 6¼ by 9 inches, published by Iowa State University Press, Ames, Iowa; $3.95.

The author's proposition is that creativity and improved decision-making ability can be developed in engineering designers. The subject is discussed under chapters entitled: Recognition, Definition, Preparation, Analysis, Synthesis, Evaluation, and Presentation.

ANALOG COMPUTATION IN ENGINEERING DESIGN

By A. E. Rogers, Electronic Associates Inc. and T. W. Connolly, Marine Div., Sperry Gyroscope Co.; 450 pages, 6 by 9 inches, published by McGraw-Hill Book Co. Inc., New York; available from AUTOMATION; *$16.00 postpaid.*

Practical techniques for using analog computers to solve problems are presented in this book. The authors discuss methods of problem preparation, show how to effectively utilize computers, and give examples of techniques as applied in such areas as chemical processing, process control, feedback control, and nuclear reactors, and in special areas where problems involve statistical phenomena.

ADAPTIVE CONTROL PROCESSES: A GUIDED TOUR

By Richard Bellman, Rand Corp.; 255 pages, 6 by 9¼ inches; published by Princeton University Press, Princeton; available from AUTOMATION; *$6.50 postpaid.*

A prime object of this book is to indicate a few of the mathematical approaches that have been successfully employed in analyzing complex control problems and systems. The intended audience of the book is mathematically trained and oriented engineers. But, as is pointed out, the theory of control processes has emerged as a mature part of the mathematical discipline and stands ready to serve a variety of fields in ways not originally envisioned.

PRINCIPLES OF SEMICONDUCTOR DEVICE OPERATION

By A. K. Jonscher, Research Laboratories, General Electric Co. Ltd., 168 pages, 5½ by 8¾ inches, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$5.00 postpaid.*

Fundamental to the operation and design of semiconductor devices is understanding of the laws governing the behavior of excess carriers in semiconductor structures. Of the opinion that other texts have neglected this area, the author has prepared this work on injection, decay, and transport of excess carrier densities in semiconductors.

Association Publications

ULTRASONIC WELDING

Paperbound, 38 pages, 6 by 8¾ inches, available from American Welding Society, 33 West 39th St., New York 18, N. Y.; $1.50.

This booklet is a reprint of a Chapter 52, Section III of the Fourth Edition of the Welding Handbook. Purpose of such reprinting is to put certain information in a form suitable for wide distribution. Topics discussed include fundamentals of ultrasonic welding, base metals welded, welding techniques, weld characteristics, quality control, equipment, and applications.

GLOSSARY OF TERMS FOR FLUID POWER

Paperbound, 31 pages, 9½ by 10¾ inches; available from National Fluid Power Association, 5595 N. Hollywood Ave., Milwaukee 17, Wis.; $1.00.

Publication covers 389 terms that were reviewed and defined by a Terminology Committee of the Association. Work is continuing on the preparation of a comprehensive glossary and the definitions are subject to revisions as the task progresses.

MODERN APPROACHES TO PRODUCTION PLANNING & CONTROL

445 pages, 6 by 9¼ inches, available from American Management Association Inc., 1515 Broadway, New York 36, N. Y.; $9.00.

Material in this book is presented in 21 chapters by authors with experience and responsibilities in the fields covered. The material was edited by R. A. Pritzker, president of Colson Corp. and Rockwood & Co., and R. A. Gring, course director, Manufacturing Div., American Management Association. Major topics covered include: Organization and Administration; Planning Tools and Control Techniques; Mechanical and Mathematic Aids, Case Studies, and Evaluation and Coordination.

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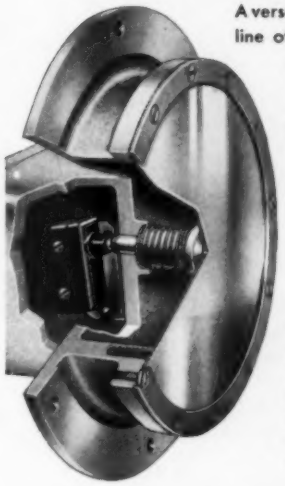

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Circle 742 on Page 35

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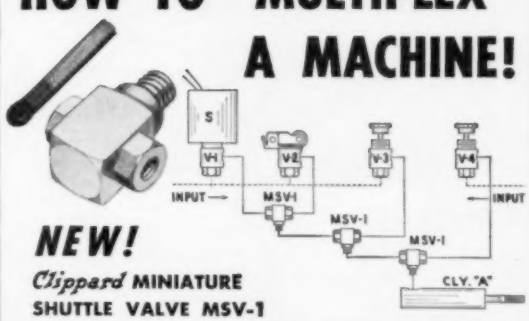

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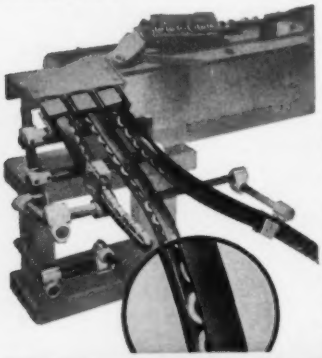

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Circle 745 on Page 35

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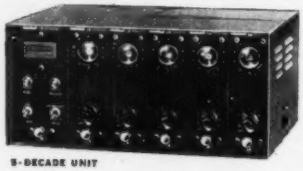

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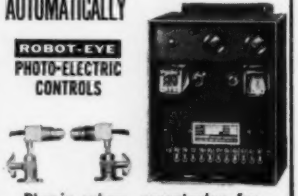

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HANDLING SMALL PARTS **Case 2300-P**

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ORIENTING GALLON JUGS **Case 2305-P**

. . . We are confronted with the problem of automatically orienting gallon jugs while they are in an upright position. We want each jug to enter a labeling machine from a conveyor belt with the jug handle forward. So far we have a set of guide rails to keep the jug handles facing forward and a device to center the jug handle just before it enters the labeler. This works very well except that a man must initially start the jug down the guide rail section to prevent the handle from being 180 degrees out of phase. Our desired rate is 25 units per minute. . . **Chemist**

CODING CHINAWARE **Case 2420-P**

. . . We are manufacturers of chinaware of the variety used in hotels, etc. Dishwashing is becoming an ever-increasing burden on the restaurant operator and is a source of losses in tableware. We have found a metal that can be put through either the first or bisque fire, be covered with glaze, and still remain a metal. Is there some kind of device that would read different code marks placed on the back of a plate and, through proper mechanisms, would sort out one dish from another so that they could be automatically stacked? Would such an identifying mark have to be electrically conductive or magnetic, or should this be one of color only? A contact with someone who has the know-how for the scanning device would be extremely interesting and further progress in this development. . . **President**

COUNTING SMALL PARTS **Case 2421-P**

. . . Our problem is to obtain an accurate count to 10's and 100's of hoppered components sliding down a 30 degree inclined chute at a speed of approximately 200 pieces per minute. At times the pieces are touching each other with no gap, which makes it practically impossible to use any light sensing arrangement. We have talked about a mechanical arrangement for counting, but I am hoping that some electrical system can be used. . . **Project Engineer**

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Circle 748 on Page 35

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Circle 749 on Page 35

CUMULATIVE EDITORIAL INDEX

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AUTOMATION *is indexed in the Applied Science & Technology Index and the Engineering Index, available in libraries generally. Microfilm copies are available from University Microfilms, 313 N. First St., Ann Arbor, Mich.*

A

Adhesives, application, 3-41
Adjustable-speed drives, 5-68
Aidlin, S. S. and S. H.
  Producing Hinged Assemblies, 2-77
Alarm, explosive, 5-20*
Alexander, W. G.
  The Importance of Knowing, 4-51
Alloying of transistor elements, 1-60
Aluminum cans, 2-79
Amplifiers,
  power, 5-77
  voltage, 5-77
Analog recording systems, 5-56
Analysis, signal energy density, 2-13*
Analyzer, fluid network, 5-26*
Assembly,
  adhesives, with, 3-41
  automobile bodies, 6-41
  automobile wheels, 4-68
  by riveting, 6-90
  copper bonding process, 3-9*
  general considerations, 3-143
  on four-slide machines, 2-68
  planning, 3-54
  power steering pumps, 1-82
  stamping, 2-39
  stators, 3-74
  toilet seats, 2-77
  transistor elements, 1-60; 3-87
Automation,
  at Volkswagen A. G., 6-41
  fifth conference, 6-10*
  French railroads, 2-47*
  in Sweden, 1-39*
  legal implications of computers, 4-56
  organization for, 2-73
  philosophy, 1-40*; 5-46
  role of data centers, 1-66
  social effect in power plants, 2-158
  stock exchange, 2-9*
  technological change, 2-154
AUTOMATION Product Review, 4-10*

B

Balancing, static, 4-68
Barrel plating, 4-13*
Batch weighing, 3-71
Beck, G. H.
  Computers & Liquid Pipelines, 6-161
Bennett, W. S.
  Programmed Testing, 5-137
Biddison, J. M.
  Automatic Assembly System, 3-74
Binary readout, 3-82; 4-70
Blechman, S.
  The Versatile Rotameter, 2-156
Bolz, R. W.
  promotion announcement, 1-13*
  Moonlight, outlook, 6-4
Bonding, of transistor elements, 1-60
Brazing,
  hydrogen, in, 1-22*
  mechanized, 3-81
Buchanan, T. C.
  Fixturing for Riveting, 6-90
Business aspects, microelectronics, 1-136*

C

Caban, N. L.
  Control Versatility, 6-155
Cam follower, 2-26*
Carlson, R. E.
  Making Parts from Wire and Strip, 2-68
Carpenter, J.
  Industrial Hydraulic Circuits, 6-71
Casting,
  aluminum engine parts, 4-39*; 6-86
  aluminum strip, 5-52
Catalog system, 4-19*
Centering machine, 1-29*

Check handling equipment, 4-30*
Checkout, 4-49*
Chemical ore reduction, 3-47*
Coating, steel pails, 5-65
Code recognition, magnetic, 4-70
Coding chinaware, prob., 6-166*
Cold forming, 1-43
Color-measuring system, 1-26*
Computers, 1-140*
  administrative control, 1-66
  aircraft maintenance, 5-73
  boiler control, 3-141
  legal implications of use, 4-56
  maintenance, 6-88
  pipeline control, 1-133*
  pneumatic, 3-13*
  power plants, 3-10*
  process control, 1-39*, 40*
  rental plans, 2-13
  small companies, 2-152
Controlled approach positioning systems, 5-77
Controls,
  adaptive, 6-164*
  automatic, 5-46
  billing, 1-50
  computer, 1-133*; 4-9*
  computers, for boilers, 3-141
  conveyor scale, 5-66
  cylinder speed, 2-86
  electrical American standards, 5-146*
  filter cycling, 1-81
  fractionator system, 3-18*
  inventory, 1-50
  load sensing conveyor, 3-78
  machine loading system, 4-90
  magnetic conveyor, 4-70
  magnetic tape, 5-56
  material feed, 2-54
  numerically controlled machine tools, 3-75
  photoelectric, 1-50; 4-94
  plastic extrusion, 3-91*
  pneumatic, 2-86
  process, 2-47*
  production, 1-50
  static magnetic, 1-73
  system, contouring, 5-24*
  systems engineering, 3-148*
  system philosophy, 4-16*
  transfer machine, 3-58
  weighing, 3-82
Conveyors,
  can, 2-79
  coal, 2-62
  finishing system, 5-84
  load sensing, 3-78
  loader, 6-67
  magnetically controlled, 4-70
  overhead, 4-63
  scale, 5-66
  systems, 5-18*
Costs, reduction, 2-159*; 5-146*
Counters,
  core-transistor, 5-10*
  word, 2-31*
Counting small parts, prob., 6-166*
Cutting, book threads, 2-61

D

Darmody, T. R.
  Maintenance of Computer Systems, 6-88
Data collection system, 2-149
Data handling, 5-46
Data processing, 1-39*; 2-9*; 4-9*
  activity in Japan, 5-42*
  battery operated computer, 5-23*
  check out equipment, 6-10*
  computer, 5-15*, 73
  digital data system, 6-18*
  French railroads, 2-47*
  graphic recording of production, 4-87
  magnetic tape, 5-56
  magnetically imprinted checks, 6-27*
  memory file, 5-10*
  mobile system, 3-18*
  multi-industry center, 4-151
  orders & invoices, 5-39*
  role of data centers, 1-66
  storage & retrieval unit, 6-26*
  tape controlled lathe, 3-62
  warehousing, in, 1-50
Davis, H. C.
  Planning Automated Assembly, 3-54

Dehydrating, onion pieces, 1-28*
Design, of fluid power cylinders, 2-86
Detector,
  fault, 3-20*
  flaw, 6-18*
Diebold, J.
  National Implications of Automation, 6-160
Digital,
  computers, 1-141*
  contactors, 4-73
  magnetic drum transducers, 4-73
  recording systems, 5-56
Dispatching, product units, 1-50; 4-70
Document retrieval, 2-13*
Dressing grinding wheels, 4-16*
Drilling,
  multiple head, 5-64
  table, 3-92
  tape-controlled, 3-9*
Drives,
  adjustable speed, 5-68
  mechanical-hydraulic, 5-68
  reversing table, 1-79
Drying, metal parts, 3-29*

E

Economics, of four-slide forming, 2-68
Electrical system testing, 4-49*
Electronics,
  in inspection, 1-138*
  maintenance, 6-88
  telephone switching system, 2-9*
Engineering,
  automated assembly, 3-54
  charges, 1-16*
  creative design, 6-164*
  use of analog computations, 6-164*
  work improvement, 1-140*
Esken, R. L.
  Elements of Automatic Assembly, 3-143
Evans, C. D.
  Organizing to Reduce Costs Through Automation, 2-73

F

Falcon, C. J.
  Load Sensing Conveyor, 3-78
Feedback systems, position, 4-73
Feeders,
  magazine, 3-87
  sheet, 6-78
Feeding,
  discrete parts, 3-87
  paper sheets, 6-78
  small parts, 1-60
Feirn, F. C.
  Sensing With Photoelectrics, 4-94
Filtration, automatic cycling, 1-81
Finishing,
  paint spray unit, 6-20*
  system, 5-84
Fixtures, riveting, 6-90
Fleishman, A. M.
  EDP in Smaller Companies, 1-66
Flow, dry meter, 1-16*
Fluid power,
  cylinders, 2-86
  terms, 6-164*
Forging presses, 5-29
Forming,
  welding chain, prob., 4-164*
  wire & strip, 2-60
Four-slide machines, 2-68
Freed, E. N.
  Legal Implications of Computer Use 4-56
Furnaces, 5-29
  electric, bottle glass, 3-13*
  industrial, 6-12*

G

Gaging,
  gamma ray systems, 6-15*
  pneumatic, 4-22*
Gleixner, H.
  Automated Materjal Control, 1-50
Gochenour, O. C.
  Planning for Maintenance, 4-155
Graphic recording of production, 4-87
Gray code, 3-82

H

Halfhill, D. W.
  Controlling with Magnetic Tape, 5-56
Handling,
  bauxite ore, 5-66
  belt lengths standardized, 6-10*
  cans, 2-79
  carburetor air horns, 6-67
  cement, 3-13*
  coal, 2-62
  conveyor system, 5-18*
  discrete items, 1-50
  dispatching bundles, 3-91*
  feeding, 3-87
  food products, 3-26*
  garments, prob., 5-142
  machine line loading, 4-90
  mail, 3-16*, 50*; 5-9*
  paper products, 6-78
  railroad wheels, 3-58
  remote controlled, 3-13*
  small parts, prob., 6-166*
  steel coils, 2-85
  transistor & diodes, prob., 2-162
  warehousing, 1-50
Heat, processing, 1-60; 4-81; 6-41
Hecox, W.
  Applying Optoelectrical Readout, 3-82
Houck, D. R.
  Inspection by Electronics, 1-138
Humphrey, J. R.
  Tricks in Handling Paper Products, 6-78
Hydraulics,
  basic sequencing methods, 6-71
  cylinder application guides, 2-86
  drive system, 5-68
  force control devices, 6-71
  position control devices, 6-71
  selector valve, 1-88
  sequencing one cylinder, 6-71
  time control devices, 6-71
  velocity control devices, 6-71

I

Imprinting filter cans, 1-80
Induction heating, 6-41
Inductive plate transducers, 4-73
Inspection,
  by electronics, 1-138*
  for automatic assembly, 1-42
  in-process, 1-60; 3-58
  paper flaws, 5-39*
  photoelectric, 1-60; 4-94
  weighing, 3-82
Instrumentation,
  response testing, 2-159*
  system, 5-18*
Investments, in overseas plants, 2-50*

J

Joining, 3-41

K

Keebler, J. C.
  Promotion Announcement, 1-13*
Justifiable Research, edit., 6-59
Kessler, G. W.
  Computer Control of Boilers, 3-141
Kirk, H. A.
  Using Patent Literature Effectively, 2-54

L

Lansky, Z. J.
  Practical Guides to Power Cylin-

*Asterisks indicate brief items appearing in departments.

der Application, 2-86
Leasing, equipment, 2-16*; 6-12*
Legal implications of computers, 4-56
Limit switches, handling control, 4-90
Linear programming, 1-141*; 2-158*
Lining, steel pails, 5-65
Lip seal testing, 4-49*
Lithographing, toothpaste tubes, 5-52
Loading,
  headed dowels, prob., 1-144*
  machine tool line, 4-90
Lubricants, selection, 2-96

M

Machine tools,
  die cutting machine, 5-15*
  drilling & tapping, 5-64
  forging presses, 5-29
  loading, 3-90*
  numerically controlled, 3-75, 92; 6-60, 85
  transfer, 2-39; 3-58
  turret lathe, tape controlled, 3-62
Machines,
  aluminum can, 2-79
  aluminum tube-making, 5-52
  assembly, 1-82; 3-74, 87
  automatic merchandising, 3-24
  Braille printing, 3-50*
  brazing, 3-81
  centering, 1-29*
  coal mining, 2-62
  dial indexing, 2-96
  drilling and boring, 2-54
  four-slide, 2-68
  joined by transfer bar, 2-82
  lapping, 6-12*
  marking, 4-42*
  plastics molding press, 4-154
  riveting, 6-90
  sawing aluminum, 5-76
  spring making, 2-16*
  thread cutting & trimming, 2-61
  thread whirling, 1-40*
  toilet seat assembly, 2-77
  wafering, 6-12*
  weighing, 3-82
  welding, 3-75; 6-9*
Magnetic,
  amplifiers, 1-73; 5-77
  conveyor control, 4-70
  core devices, 5-146
  pin transducers, 4-73
  tape systems, 5-56
  tooth transducers, 4-73
Magnetic tape,
  controlled lathe, 3-62
  preparation center, 4-83
Magnetism, eliminating residual, problem, 1-144*
Maintenance, 5-45
  aircraft with computer, 5-73
  computer, 6-88
  data collection, 2-149
  of fluid power cylinders, 2-86
  programmed mill, 4-156
Management,
  information & control system, 2-148*
  of distribution function, 6-164*
Manufacture of,
  alternator stators, 3-74
  aluminum cans, 2-79
  asbestos cigarette filters, problem, 1-144
  automobiles, 4-68; 6-41
  automotive parts, 1-43, 82; 2-39; 3-41; 4-81; 5-29
  bakery products, 1-39*
  books, 2-61
  concrete, 3-71
  concrete tiles, 4-39*
  connecting rods, 4-90
  copper & copper products, 3-47*
  electric motors, 4-81
  engine blocks, 2-39
  engine castings, 6-86
  floor tile, 4-64
  forgings, 5-29
  hats, 2-50*
  liquid carbon dioxide, 1-10*
  magnetic tape, 5-12*
  microelectronics, 1-136*
  pails, 5-65
  petroleum products, 2-47*
  pipe, 5-68
  pumps, 1-82
  quartz crystals, 1-9*
  railroad wheels, 3-58
  sheet metals, 3-10*
  shingles, 4-93
  strip parts, 2-68
  toothpaste tubes, 5-52
  transistors, 1-60; 3-16*, 87
  tubular heating elements, 2-82
  typewriter parts, 5-84
Volkswagen cars, 6-41
  wire parts, 2-68
Manufacturing engineering, 4-10*
Manufacturing Engineering Council, election of officers, 6-12*
Manufacturing research, 2-73; 6-59
Mastic application, 2-39
Mathematics, 3-148
Measuring,
  color of molding compounds, 1-26*
  moisture, 2-13*
  tensile, test specimens, prob., 5-142
  tension in filaments, 4-26*
Memory techniques, 1-50
Memory wheel, 2-54
Meters,
  dry flow, 1-16*
  torque and horsepower, 1-23*
Microelectronics, attributes, 1-136*
Miller, R. H.
  Pump Assembly Machine, 1-82
Mining coal, 2-62
Mixing, 2-16*; 4-64
Mobile concrete batcher, 3-71
Modersohn, C. W.
  Mechanical-Hydraulic Drive, 5-68
Moe, J. E.
  Magnetic Tape Control of Turret Lathe, 3-62
Molding,
  Braille characters, 3-50*
  glass, prob., 2-162*
Motors,
  dc, 5-12*
  theory and repair, 1-141*
Mounting, fluid power cylinders, 2-86
Muschamp, G. M.
  Tomorrow's Integrated Offices and Plants, 5-46

N

Network synthesis, 2-158*
Numerical control, 4-10*
  magnetic tape for, 5-56
  management considerations, 6-60
  milling machine, 6-85
  structural steel drilling machine, 3-75
  tape preparation centers, 4-83
  turret lathe, 3-62

O

Office automation, 5-46
Olesten, N. O.
  Steppingstones to Numerical Control, 6-60
O'Neill, B. J.
  Control by Static Magnetic Switching, 1-73
Optical gratings, 4-73
Optoelectrical readout, 3-82
Order picking, 1-50
Organization, for numerical control, 6-60
Organizing for automation, 2-73
Orienting gallon jugs, prob., 6-166*

P

Packaging,
  carton strapping, 6-22*
  machines, tetrahedron, 4-10*
  napkin, 3-91*
  transistors, 4-16*
  undergarments, prob., 4-164*
Painting, 3-75; 5-84; 6-41
  strip aluminum, 3-16*
Pasteurizer-cooler, 6-24*
Patent classifications, 2-54
Patterson, K. M.
  Improved Manufacturing Flow, 5-139
Photoelectric, control, 1-50; 4-94
  in-process inspection, 1-60
Pie coating, 4-93
Pipeline, computer controlled, 1-133*
Pipes,
  bimetallic, 2-24*
  continuous buttweld, 5-68
Planning,
  automated assembly, 3-54
  production inventories, & work force, 3-150*
  profit, 1-140*
Plumbing terms, 3-150*
Pneumatic,
  cylinder application guides, 2-86
  hydraulic positioning system, 1-88
  valves, 1-39*
Positioning,
  controls, 4-73
  system, 1-88; 5-77; 6-23*
Potentiometer position transducers, 4-73
Presses,
  block, safety, 3-22*
  laminating, 3-28*
Printer, rotary spot, 6-15*
Printing tubes, electrostatic, 2-30*
Process,
  bauxite ore refining, 5-66
  coal mining, 2-62
  copper reduction, 3-47*
  pail lining, 5-65
  paper products, 6-78
Production control, 4-87, 92; 6-164*
Production of electronic circuit components, 2-16*
Programming,
  classes, 6-22*
  electrical test, 4-49
  mill operation, 6-20*
  numerical control, 6-60
  winding memory planes, 1-10*
Psychology, industrial, 2-158*
Pulse transducers, 4-73
Pumps,
  flexible tube, 4-24*
  multipurpose, 2-19*
Punched tape,
  maintenance data collection, 2-149

Q

Quinn, J. D.
  Recording Performance Data, 2-149

R

Railroads, automatic identification of equipment, 3-9*
Ray, W. A.
  Control System Philosophy, 4-16*
Reading, car numbers, problem, 1-144*; 3-154*
Recall, from storage, 1-50
Recorders,
  graphic display production data, 4-87
  magnetic tape, 5-56
  microfilm, 4-10*
  temperature, 6-77
Rectifiers, industrial, 3-13*
Research, manufacturing, 6-59
Resolvers, 4-73
Richardson, R. E.
  Computer Aids Pipeline Control, 1-133
Riveting, 6-90
Robertson, M. E.
  Comments on Technological Change, 2-154
Rolling steel bar products, 4-93
Rotameter, 2-156
Rubber lining material, 6-10*

S

Sand reclamation system, 4-31*
Sarnoff, D.
  Potential for the Sixties, 3-147
Saturable reactors, 1-73
Sawing machine, 5-76
Seals, for fluid power cylinders, 2-86
Selecting fluid power cylinders, 2-86
Semiconductor device operation, 6-164*
Sensing,
  cutting depth, prob., 3-154*
  drill breakage, prob., 3-154*
  scored lines, prob., 1-144*
Sensors,
  magnetic, 4-70
  photocell, 4-94
  weather, 3-16*
Servo positioning systems, 5-77
Servos, incremental, prob., 3-154*
Setscrew driving, 4-92
Shenton, D. W.
  Automated Material Control, 1-50
Shift register, 1-50
Sieve plates, 1-19*
Sintering, copper powder, 3-47*
Soldering type bars, prob., 2-162
Sorting,
  by weight, 2-54
  paper sheets, 5-39*
  photoelectric control, 4-94
  punched cards, 2-54
Speaker, R. L.
  Distribution Materials Handling, 6-157
Speed, regulator, 2-54
Spot welding, 1-16*
Stackers, paper sheet, 6-78
Stacking parts, prob., 4-164*
Stampings, assembly of, 2-39
Standards,
  electrical diagrams, 3-150*
  fluid power cylinders, 3-150*
  signalling apparatus, 3-150*
Statement processing, 1-16*
Static balancing, 4-68
Static magnetic switching, 1-73
Stern, A. P.
  Attributes & Implications of Microelectronics, 1-136
Storage, 1-50
  information, 1-50
  steel, 3-90*
Straightening tubing, 3-90*
Strip forming, 2-68
Stripping insulation, prob., 4-164*
Supervisory control, pipelines, 1-33*
Switching circuits, for position transducers, 5-77
Switching, static magnetic, 1-73
Synchros, 4-73

T

Tape,
  magazine, interchangeable, 2-28*
  preparation, 3-62
Tape control,
  drilling machine, 3-92
  preparation centers, 4-83
  turret lathe, 3-62
Tapping, multiple head, 5-61
Telemetering, 5-46
Temperature,
  measuring photocell, 4-96
  monitoring system, 1-19*
  recording system, 6-77
Testing, 4-49*
  air conveying systems, 2-22*
  kiln temperatures, 6-77
  power steering pumps, 1-82
  tubular heating elements, 2-82
  wires, 6-28*
Thurman, C. H.
  Plant Modifications for Computer Control, 5-135
Tool setting comparator, 4-28*
Toothed magnetic drum transducers, 4-73
Trade-in plan, screw machines, 1-13*
Transducers,
  photocell, 4-94
  position, 4-73
Transfer devices, 2-82
  machines, 2-39
  machining & assembly, 4-92
Transfer machines,
  carburetor air horns, 6-67
Transistor, 2-159*
  amplifiers, 5-77
  assembly, 3-87
  strip alloying process, 3-10*
Trimming, book threads, 2-61
Troupe, W. B.
  Continuous Heat Processing, 4-81
Turnovers, 6-67
Tying knots, prob., 4-164*

V

Vacuum, parts feeding, 1-60; 3-87
Vacuum tube amplifiers, 5-77
Valves,
  control, 1-39*
  pneumatic-hydraulic selector, 1-88
  testing, 4-49*
Van Horne, W. E.
  Graphic Recording of Production, 4-87
Verification of control tapes, 4-83
Vibrating small masses, prob., 2-162*
Vibrational compactor, 2-20*

W

Walker, J. R.
  Elements of Positioning Controls, 4-73; 5-77
Warehousing, 1-50
  operations planning, 3-148*
Water filtration, 1-81
Weighing,
  batch, 3-16*
  binary code, 3-82
Weissman, L.
  Control by Static Magnetic Switching, 1-73
Welding,
  arc spot, for aluminum, 1-22*
  assembly machine, 1-60; 6-41
  auto bodies, 6-41
  coil ends, 2-85
  of transistor elements, 1-60
  pipeline, 4-13*
  spot, 1-16*
  ultrasonic, 6-164*
Wesley, G. A.
  Computers & Small Companies, 2-152
Wilburn, R. C.
  Answers to Numerical Control, 4-83
Wilson, R.
  Compression Molding Cost Factors, 4-154
Winding, stator coils, 3-74
Winter, A. C.
  Computer Aids Pipeline Control, 1-133
Wire, forming, 2-68

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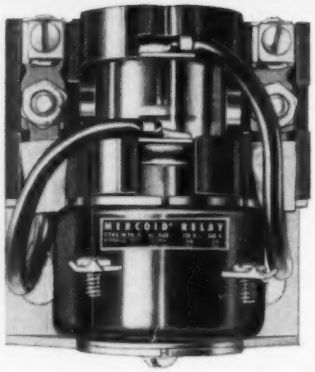

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WRITE FOR BULLETIN 0-20

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Circle 750 on Page 35

Advertising Index

AE Industrial Division of Aircraft Armaments, Inc. 167
AMP, Inc. 32
Aircraft Armaments, Inc., AE Industrial Division 167
Allen-Bradley Co. 99, 100
Allis, Louis, Co., The 48, 49
Alvey Conveyor Manufacturing Co. 125
Alvey-Ferguson Co., The 23
Apex Machine & Tool Co., The 15
Armour Research Foundation of Illinois Institute of Technology 163
Artos Engineering Co. 152
Assembly Products, Inc. 142
Automatic Switch Co. ..... Back Cover
Automation Development Corporation 150

B-I-F Industries, Inc. 24
Barksdale Valves, Pressure Switch Division .. 145
Bellows-Valvair Division of International Basic Economy Corporation 139
Bendix Corporation, The 19
Bin-Dicator Co., The 165
Brown Filling Machine Co., Inc. 167
Brown, James G., & Associates 165
Buschman, E. W., Co., The 105

Campbell Machine Co. 166
Chicago Rivet & Machine Co. 18
Cincinnati Milling Machine Co., The 6, 7
Cleveland Tramrail Division of The Cleveland Crane & Engineering Co. 51
Cleveland Vibrator Co., The 161
Clippard Instrument Laboratory, Inc. 165
Control Engineering Co. 21
Conveyor Systems, Inc. 40
Crown Zellerbach Corporation, Gaylord Container Division 46
Cutler-Hammer, Inc. 42, 43

Delavan Manufacturing Co. 103
Detroit Power Screwdriver Co. 151
Diamond Chain Co., Inc. 143
Dynamatic Division of Eaton Manufacturing Co. 123
Dynapar Corporation 50

Eaton Manufacturing Co., Dynamatic Division 123
Eaton Manufacturing Co., Farval Division 8
Eriez Manufacturing Co. 28
Euclid Electric & Mfg. Co., The 156
Exact Weight Scale Co., The 27

Farval Division of Eaton Manufacturing Co. .. 8
Fawick Corporation, Fawick Airflex Division .. 114
Federal Products Corporation 138
Fort Wayne Tool, Die & Engineering Co. 158
Fosdick Machine Tool Co., The 121
Fostoria Corporation, Infrared Division 29
Friden, Inc. 107
Fuller Co. 52

Galland-Henning, Nopak Division 117
Gardner-Denver Co. 172
Gaylord Container Division of Crown Zellerbach Corporation 46
Gemco Electric Co. 167
General Electric Co. 16, 17
General Electric Co., Industrial Sales Operations 38, 39
Greenlee Bros. & Co. 2

Hamilton Standard Division, United Aircraft Corporation 149
Hanna Engineering Works 1
Hannifin Co. A Division of Parker-Hannifin Corporation 153
Hinde & Dauch Division of West Virginia Pulp & Paper 13
Horsburgh & Scott Co., The 146
Hunt Valve Co. Division of International Basic Economy Corporation 37

Illinois Institute of Technology, Armour Research Foundation 163
Industrial Electronic Engineers, Inc. 157
Industrial Marking Equipment 136
International Basic Economy Corporation, Bellows-Valvair Division 139
International Basic Economy Corporation, Hunt Valve Co. Division 37

Lipe-Rollway Corporation 122
Logansport Machine Co., Inc. 129
Louden Machinery Co., The 127

Magnetics, Inc. 131
Mead Specialties Co., Mead Fluid Dynamics Division 14
Mercoid Corporation, The 170
Merrick Scale Manufacturing Co. 160
Mid-Continent Screw Products Co. 163
Milford Rivet & Machine Co., The 128
Minneapolis-Honeywell Regulator Co. 133
Moline Tool Co. 144

National Acme Co., The 109
National Vulcanized Fibre Co. 134

Ohio, State of, Department of Industrial & Economic Development 11
Oilgear Co., The 5
Ortman-Miller Machine Co. 25

Parker-Hannifin Corporation, Hannifin Co. Division 153
Planet Corporation ..... Inside Front Cover
Post Electronic Products Division of Reid Brothers Co., Inc. 111
Precision Detroit Co. 130

Racine Hydraulics & Machinery, Inc. 137
Radcor, Inc. 20
Radio Corporation of America .. Inside Back Cover
Rapids-Standard Co., Inc. 147
Reid Brothers Co., Inc., Post Electronic Products Division 111
Richards-Wilcox Mfg. Co. 163

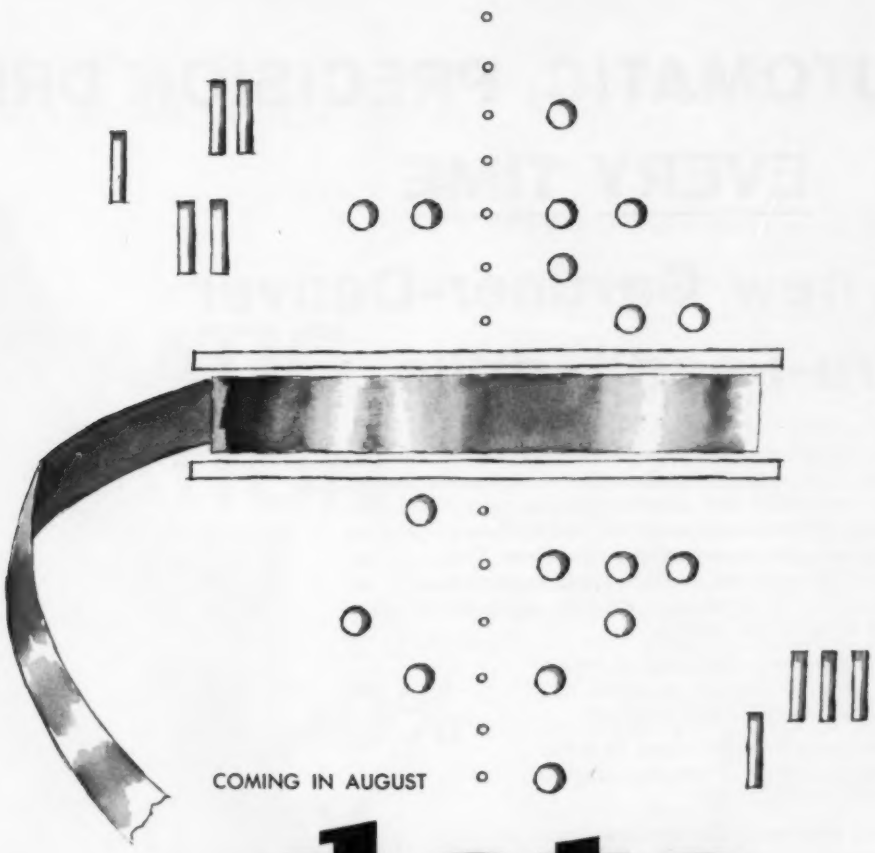
SPO-Milwaukee, Foundry Equipment Division .. 113
Sandvik Steel, Inc. 148
Sealmaster Bearings A Division of Stephens-Adamson Mfg. Co. 22
Seneca Falls Machine Co. 124
Ses-Matic Press Equipment Division of Special Engineering Service, Inc. 162
Simplicity Engineering Co. 165
Special Engineering Service, Inc., Ses-Matic Press Equipment Division 162
Sperry Gyroscope Company of Canada, Ltd. .. 154
Sperry Rand Corporation, Vickers, Inc. Division 140
Springport Steel Products Co. 163
Standard Conveyor Co. 135
Standard Instrument Corporation 166
Stephens-Adamson Mfg. Co., Sealmaster Bearings Division 22
Sterling Electric Motors, Inc. 30, 31
Stromberg-Carlson, General Dynamics Electronics 26
Swanson-Erie Corporation 119

Thayer Scale Corporation 132
Toledo Scale Corporation 126
Tomkins-Johnson Co. 45

United Aircraft Corporation, Hamilton Standard Division 149

Vickers, Inc. Division of Sperry Rand Corporation 140

Wagner Electric Corporation 144
Weighing & Controls, Inc. 120
Westinghouse Electric Corporation 53, 54, 55, 56, 57, 58, 159
West Virginia Pulp & Paper, Hinde & Dauch Division 13
Wiegand, Edwin L., Co. 20



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Circle 751 on Page 35

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Circle 752 on Page 35

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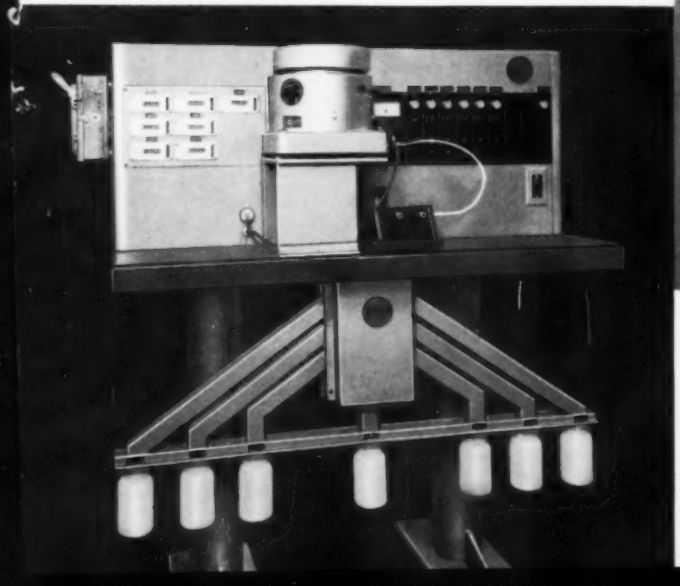

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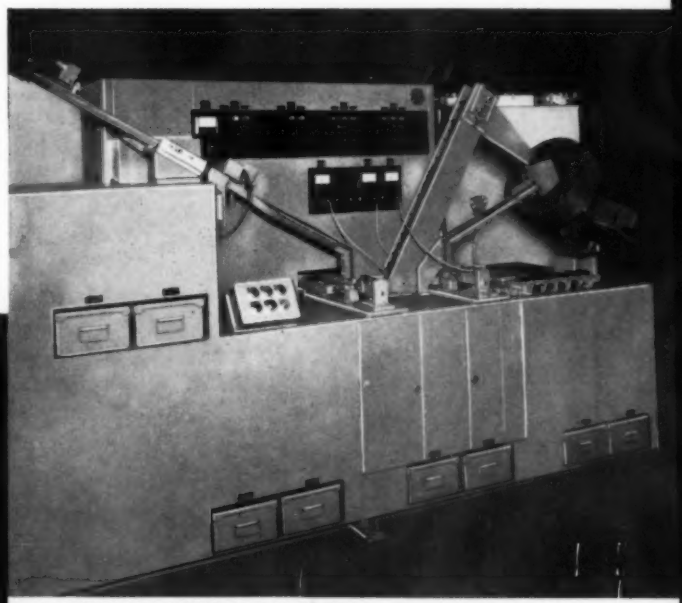

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Circle 652 on Page 35

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Circle 653 on Page 35